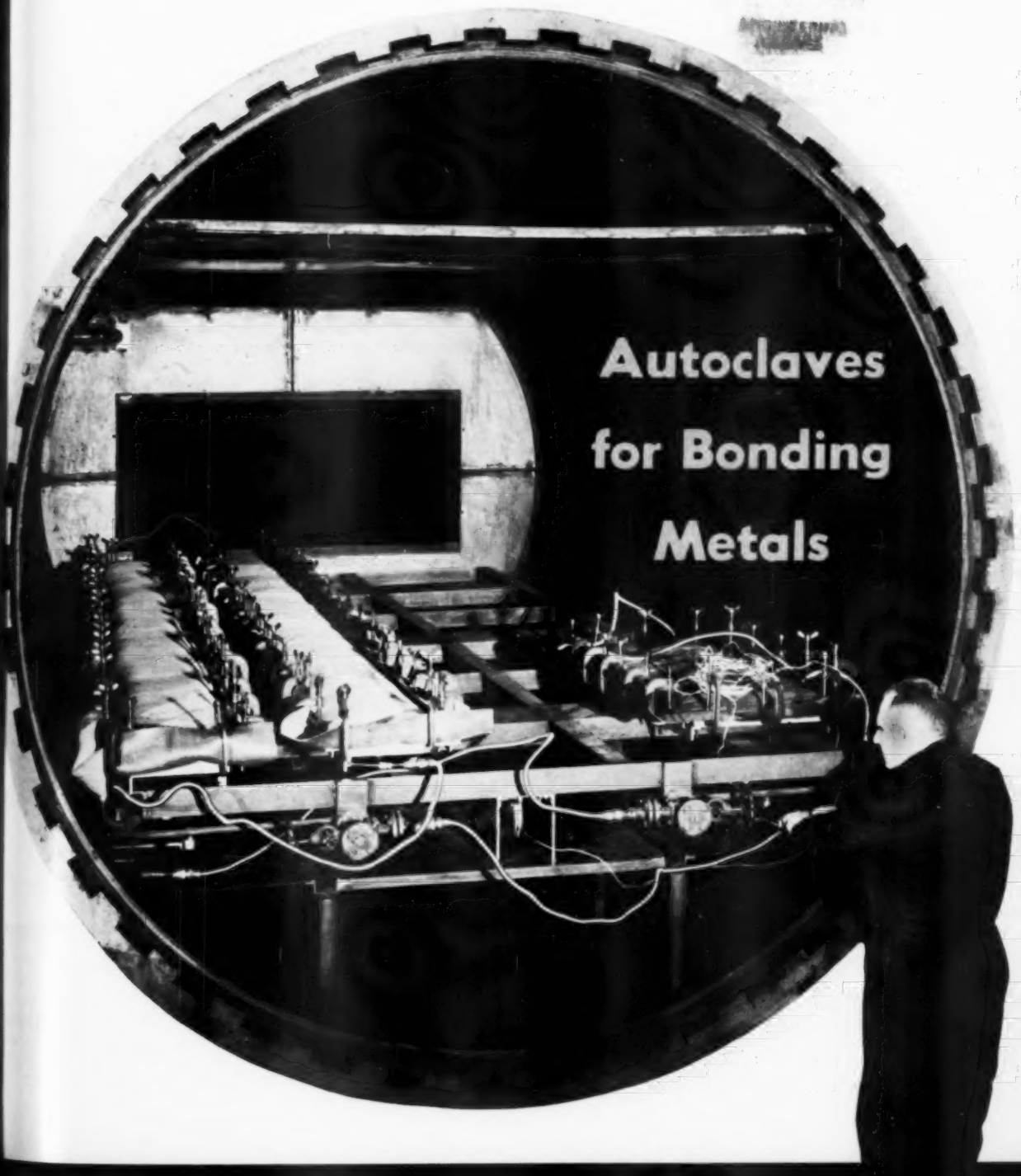
ANUARY, 1961

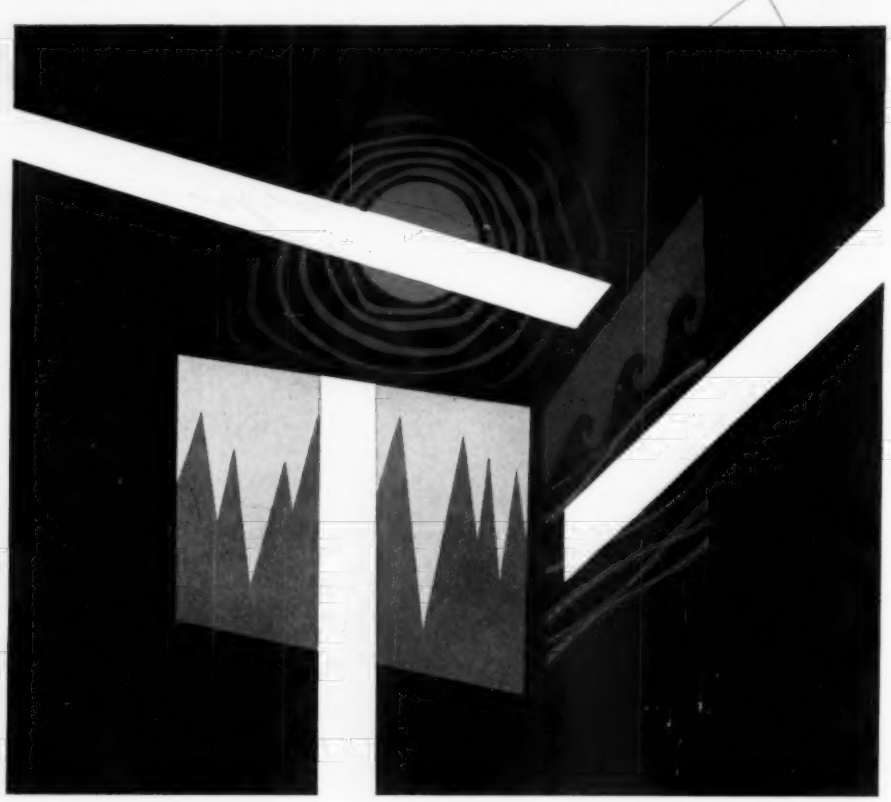
ADHESIVES AGE

MANUFACTURE, APPLICATION, TECHNOLOGY, RESEARCH AND MARKETING



SILICONE NEWS from Dow Corning

Sticks Here...Here...Here



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Or alone. For a fastening adhesive in rugged service, silicones may be your answer. For example, silicone adhesives in combination with asbestos fibers are used to coat and insulate hot air ducts in aircraft. Other tough applications: sealing ends of heat elements in appliances, bonding mica and asbestos panelboard, and bonding silicone rubber to the coils of electrical equipment.

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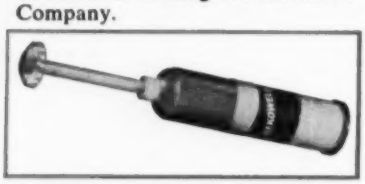

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ADHESIVES AGE

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About the Cover Photograph

The interior view of an autoclave at Sir W. G. Armstrong Whitworth Aircraft Ltd. relates to a detailed article on autoclave bonding in the British aircraft industry, page 20 of this issue. Exposed are the heat distribution channels, and heating and cooling coils. The autoclave is mounted below floor level to facilitate loading and unloading operations. Baffles have been provided at the top and bottom of the unit to form a heating chest for work and two feed channels for hot air.

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PALMERTON PUBLISHING CO., INC.

JANUARY, 1961

VOL. 4, NO. 1

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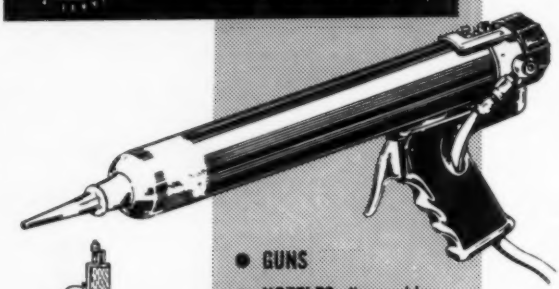

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EDITORIAL

A Guest Editorial

"Percentage Solids" and Adhesive Cost Comparison

Before a valid unit-cost-per-completed-assembly can be determined for *any* fastening technique . . . for adhesives as well as for welding rods, staples, bolts, and the like . . . certain obvious considerations must be investigated thoroughly: ease and speed of application; caliber of personnel required; specialized equipment involved (or eliminated); pre- and post-cleaning needs; after-finishing costs; etc.

Peculiar to adhesives, however, is the matter of what might be called "percentage of *working* solids" of the formulation as it relates to the *effective* bond line thickness. This factor usually represents the cost analysis area which directly and specifically determines which product will accomplish the joining operation most economically. This is particularly true where large-volume, large-area-coverage bonding is involved—such as is encountered in laminating fabrics, foils, or films, and in the fabrication of curtain wall panels, for example.

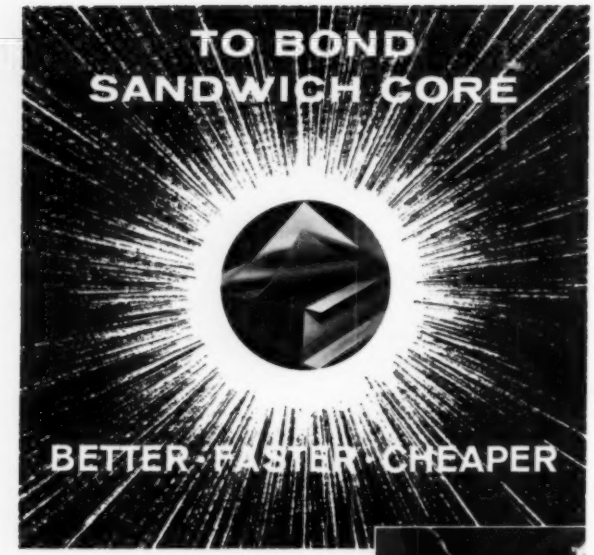
Since the most important single consideration in adhesive cost comparison is the cost-per-dry-mil-thickness of the *completed* bond line, a cursory comparison of a solvent- or water-dispersed adhesive priced at $3.10 per gallon versus one priced at $3.35 or even $3.45 per gallon need not necessarily indicate their true competitive cost relationship. If the first product has a solids content of 20 per cent, and the second a 25 per cent solids content, the latter, when properly applied to equivalent specified dry film thickness, may very well give not only more square feet of glue line per gallon, but more square feet per dollar.

Similarly, a so-called "100 per cent solids" adhesive may be extended with heavy filler content so as to enable it to be priced at, say 60¢ per pound. Despite this seemingly low cost, however, its high specific gravity may actually result in its being invoiced out at $10.00 per gallon with a resultant effective glue line cost substantially higher than originally anticipated.

In fact, a constantly growing number of adhesives users are beginning to appreciate the fact that, for many applications, a "non-degraded" 100-per cent-reactive, solvent- and filler-free formulation priced at, say, as much as $1.00 per pound or more, may yield an even lower finished cost than either of the previous two mentioned!

Now that more and more production people are adopting a "value analysis" approach to their fastening problems, the increasing importance of "percentage solids" and "specific gravity" (weight per gallon) has led some of the leading adhesive manufacturers to include this information as part of individual product designations. With greater awareness of this important area of cost control, it is reasonable to assume that more intensive consideration of this factor will become one of the basic starting points for adhesive evaluation programs . . . and rightly so.

BERNARD GOULD
Manager, Market Development
Rubber and Asbestos Corp.
Bloomfield, N.J.



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Room temp. peel strength (in.-lbs per 3-in. width) 125
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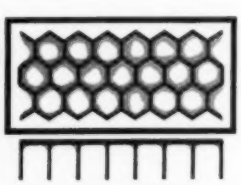

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CONSULTANT'S CORNER

By Dr. Irving Skeist

Polyethylene

Question: Can you suggest some methods, other than heat sealing, for joining polyethylene sheet materials? The technique would have to offer: high shear and peel strength, good creep resistance up to 150°F., resistance to moisture and outdoor exposure, good pliability, and initial tack sufficient to enable handling immediately after joining. In addition, it would have to be suitable for commercial application at high speeds.

Answer: Heat sealing is still the only sure method of getting "tear seal" strength in polyethylene bonds. If you will settle for moderately strong bonds, you can satisfy your other requirements by flame-treating the polyethylene to provide a slightly oxidized surface, and then using a hot melt composition comprising polyethylene. One supplier offers a hot melt in rope form, while another source has granulated hot melts which can be extruded as a tape. *Q-177*

Abhesive Coating

Question: We need a readily removable protective coating to apply to Formica surfaces. The problem is to prevent adherence of glue squeeze-out when a Formica edge band is applied with urea formaldehyde and a hot bar.

Paste waxes, silicones, etc., remove easily but do not give sufficient protection. They either wipe off in handling, or melt and chase back from the edge during the curing cycle. Strippable coatings do not cut cleanly, and pull loose in jointing and shaping operations between application and gluing. Vinyl type floor waxes give excellent protection but are very difficult to remove.

Answer: A polyvinyl butyral solution sprayed on the edge may work. The simplest technique, however, would be a masking tape. *Q-178*

Dr. Skeist is associated with Skeist & Schwarz Laboratories, Inc., 89 Lincoln Park, Newark 2, N.J. He is the author of the recently published book, "Epoxy Resins."

Glass to Plaster

Question: I made two fused stained glass murals consisting of 36 panels, each 21x17½ inches. The murals were attached to the plaster walls of a hotel. Since there was no light behind the glass, I coated the panel backs with white lacquer so that light would go through the stained glass and bounce back out again.

The workers who installed the panels first coated the lacquer with mastic size, a black liquid, and checked to see if this would react with the lacquer. Since no reaction was evident, the panels were put on the wall with about five blobs of heavy black-brown mastic of the sort used for attaching linoleum. The actual weight of the glass was held by narrow strips of metal, so strength was no special problem.

After nine months, dark blotches appeared where the mastic was applied. It probably ate through the size and attacked the lacquer. Can you recommend a mastic that will not react with lacquer? We could pull the panels off and repaint over the lacquer with an epoxy base white paint capable of resisting any mastic. However, it would be much simpler if we could find a mastic that will not bother lacquer.

Answer: Two solutions are suggested. First, the mastic could be replaced by a non-staining neoprene adhesive. Be sure you purchase it as "non-staining."

Better still, you should be able to replace both lacquer and mastic with a single composition—an epoxy having good adhesion to both glass and plaster. White pigment (titanium dioxide) can be ground into the epoxy resin to provide the reflecting surface. Curing can be accomplished without application of external heat by the use of a suitable flexibilizing amine hardener.

Q-181

Corrugated Container Flaps

Question: Can you suggest a practical way of applying self-sealing adhesive to the flaps of corrugated containers?

Answer: Growers Container Co. licenses a patented process and machinery for this operation. Both sides of the flap are coated with a formulated natural rubber latex, the water is evaporated in an oven, and the unsealed carton is shipped in such a manner that the coated surfaces never come into contact.

Q-179

Backlined Book to PVC Cover

Question: We are experimenting with book covers made of flexible and rigid polyvinyl chloride. However, we have been having trouble finding a suitable adhesive for casing-in a backlined book. Can you suggest some types of adhesives that would do the job?

Answer: Nitrile rubber (butadiene-acrylonitrile rubber), with or without added vinyl chloride polymer, gives good adhesion to polyvinyl chloride. The backlined book presents no difficulty with this adhesive material. The adhesive should be in a ketone solvent to "bite into" the vinyl.

Q-182

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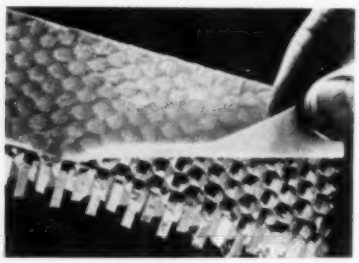

epoxy adhesives. It provides uniform adhesive thickness throughout the assembly, controlled confinement of adhesive to the immediate bonding area, clean bonding operations, and simple application procedures. Because it does not contain solvents, waste and shrinkage are avoided and solvent hazards and drying problems are eliminated, states the manufacturer. Available in varying widths and thicknesses, it can be cut to fit the honeycomb assembly. The adhesive provides metal-to-metal bonds with shear strengths of over 2000 psi at 75°F. It maintains high strength over a service temperature range of —67°F. to 300°F. and has excellent peel strength. Maximum strength is obtained with a one hour cure at 350°F. under 25-50 psi. *Adhesives, Coatings, and Sealers Division, Minnesota Mining & Mfg. Co.*

P-426

Vegetable-Based Adhesive

Designed specifically for adhesive spray applications in paper mill roll-heading or mill-end-wrapping operations, Cascola CS-257 is a low viscosity, vegetable-based adhesive. It is said to atomize at extremely low spray pressures, is non-clogging and very fast setting. It can be used on nearly all conventional spray equipment. The roll-head adhesive is available in 55-gallon drums and five-gallon pails. *Borden Chemical Co.*

P-427

Self-Extinguishing Epoxies

Two newly available epoxy resins are made self-extinguishing by substituting bromine on the epoxy molecule. They are designed for use in aircraft and missile adhesives, laminated aircraft structures, glass and paper-based laminated electrical circuits, and filled castings. Experimental Resin X-3442 is a semi-solid containing about 49 per cent bromine and can be used in blends with conventional liquid epoxy resins. Experimental Resin X-3441 is a solid resin containing about 19 per cent bromine and can be used either alone or in blends with conventional solid resins. The physical and electrical properties of laminates made with these resins are comparable to properties developed by conventional epoxies. *Dow Chemical Co.*

P-428

Adhesion Promoter

Poly-Prep is designed to promote adhesion to both polyethylene and polypropylene plastics by a chemical process which prepares the surface of these plastics by oxidation and by the deposition of an invisible molecular film. It may be used for application of lacquer and paint coatings, adhesive bonding, print and silk-screening on both plastics, vacuum metalizing, and reduction and electro-deposition of metals. Poly-prep is used at room temperature. The article to be treated is dipped into the solution for 15 to 30 seconds, then rinsed in clear running water and dried before application of the product. *Chemclean Products Corporation.*

P-429

Synthetic Wax

Slip, viscosity, flow, spreading and setting characteristics of resin and elastomer compositions may be changed by the addition of waxes. Ross Wax 160, a synthetic wax, was designed by the manufacturer for use in hot-melt coatings, adhesives and sealants. Samples on request. *Frank B. Ross Co., Inc.*

P-430

Gelatin Stripper

Epoxy and polyester-based coatings can be removed with a new gelatinous, self-activating stripping agent designated as Tele-Solv G. It can be applied by brushing or spreading, and it will adhere to all contoured or vertical surfaces. Quick drying, the compound begins its stripping action upon application. The residue is said to be easily removed and parts or surfaces can be worked on immediately without cleaning or further treating. It will

not corrode, discolor, or damage copper, aluminum, or ferrous metals. Tele-Solv G is nonflammable and nonacidic. No special equipment or mixing is required. *Narmco Industries, Inc.*

P-431

Casein Glue

Extra protection against mold and fungi that develop on wood and in glue lines in humid conditions is said to be built into 30-CP, a casein glue with a specially formulated preservative. The manufacturer recommends it for use on glue-nail trusses as well as for laminated beams and millwork of all kinds. It provides a bond which passes Specification MMM-A-125. 30-CP is a brown powder which mixes readily with water to yield a creamy, free-flowing glue that can be spread by brush, mechanical roller or trowel. It is said to be especially adapted for gluing resinous woods such as fir or pine. The glue will withstand heat, weathering, high or low humidity, gasoline and oil, states the manufacturer. *National Casein Co.*

P-432

Epoxy System

Hysol 10-001 is a two-component epoxy system for bonding aluminum honeycomb panels where high peel strength is mandatory. Thixotropic, easy to apply and chemical resistant.

ADHESIVES GUIDE

by JOYCE HURD

• A Practical Handbook

designed to serve as a guide to the types of adhesives available for bonding various materials in various applications. This new British publication covers adhesives used in woodworking, bookbinding, footwear, etc., and offers valuable data on the advantages of adhesive bonding and the classification of adhesives.

Topics Covered

Choice of Adhesives for Various Materials.

Encyclopedia of Basic Adhesive Types.

Classification of Manufacturers (British) by Basic Types of Adhesives Made

Catalog of Adhesive Manufacturers and Their Products

Trade Name Index (British)

Miscellaneous Adhesive Recipes

British Organizations Concerned With Adhesives

Bibliography

With contents including data on something like 400 individual adhesives made by about 100 different manufacturers, this publication will prove to be a valuable edition to your technical library. More than 50 main types of adhesives and their properties are covered!

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the adhesive has a pot life of three to four days at 25°C. The manufacturer recommends it for use with ferrous metals, ceramics and glass. Offering a peel strength of 63.3 in./lbs. and a tensile shear strength of 3300 psi, the adhesive is prepared by mixing 150 parts by weight of component A to 100 parts by weight of component B. It can be mixed by volume at a ratio of 1:1. Application is by doctor blade, sealant gun or brush. Cure may be accomplished by 16 hours at 102°C., four hours at 135°C., or one hour at 160°C. The formulation is orange in color and has a shelf life of six months. *Hysol Corp.*

P-433

Repair Kit

The Devcon F Repair Kit was developed for repairing castings, valves, pumps, core boxes and other types of industrial machinery. It consists of two three-ounce self-measuring tubes. One tube contains Devcon F, an aluminum and epoxy mixture, and the other tube contains a hardening agent. In application, equal lengths of material are squeezed from each tube and mixed with a wooden paddle included in the kit. The cured compound does not shrink and is said to exhibit good adhesion to steel, iron, aluminum, bronze, glass and many other surfaces. *Devcon Corp.*

P-434

Silicone Rubber Tapes

Made of unsupported silicone rubber, Mox-Tapes are available in three different types. The 600 series is self-adhering. Normal wrapping pressure is enough to bond layers of this tape together. The bond is inherent in the rubber itself, though the tape is not tacky to the touch. A semi-cured form of silicone rubber is used in the 800 series which is recommended when the finished product should be void free. It is practical to use a bonding paste to obtain adhesion between layers. The 900 series is fully cured silicone rubber products for applications requiring chemical stability but where there is no possibility of post cure after assembly. The last two digits of a series number indicate the tape thickness in mils. Thus, 612 indicates a tape thickness of .012". *Moxness Products, Inc.*

P-435

Silicone Rubber Cement

Silicone rubber can be bonded to itself or glass, Dacron, and nylon with COHRlastic C-251, a silicone rubber thermal-curing cement with an effective temperature range of from 100° to 500°F. Bond strengths vary from eight to 15 psi peel strength depending upon the formulation of the silicone rubber to be cemented. The adhesive can also be used with COHRlastic C-260 Metal Primer to bond silicone rubber to metal, plastics and ceramics. *Connecticut Hard Rubber Co.*

P-436

Rubber Calk

Designed for use in sealing joints in concrete of airport runways, taxi strips and aprons, PRC Rubber Calk 100 will withstand fuel and oil spillage, weather and jet engine blasts. It is formulated for quick tack-free application. Pavement sealed with this compound may be placed in service with a minimum loss of time, states the manufacturer. In twenty minutes the calk is firm and flexible; it is completely cured in 24 hours. No primer is required for application to clean concrete joints. *Products Research Co.*

P-437

Mylar Decals

The toughness and attractiveness of Mylar are combined with a Permacel adhesive in a decal material designated as Decalar 956. The three-mil metalized Mylar is available in chrome and gold and can be die-cut and silk screened with standard screen processing inks or enamels. The adhesive back has a low initial tack and builds up to an adhesion of over 90 ounces per inch width within 24 hours. A slit-free interliner eliminates wrinkles, creases and improper ink deposits. An overall thickness of almost five mils is said to make Decalar ideal for use on surfaces that are not perfectly smooth. Surface imperfections will not show through or puncture the decal. The adhesive and backing are impervious to oil, grease, gasoline, solvents, detergents, water, etc., and will adhere to wood, metal, leather, and plastic surfaces. *Permacel.*

P-438

Reinforced Gummed Tape

Stres-Pruf E. O. gummed tape is non-asphaltic glass fiber reinforced. It has a top layer of reinforced construction that can be ripped off a sealed carton, leaving only a thin Kraft layer that can be easily popped. The two-layer tape closure is designed to save time and to avoid damage to both the carton and its contents. *Mid-States Gummed Paper.*

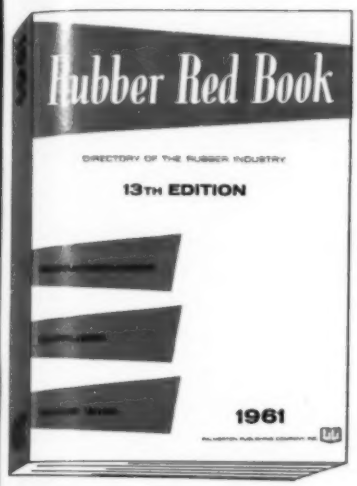
P-439

Pressure-Sensitive Trim

Decor-Stik, a metalized combination of Mylar and vinyl with a pressure-sensitive backing, has been developed for designers and manufacturers with a product to trim or decorate. It is pressure-sensitive and can be applied permanently to any surface that is clean, dry, flat and rigid, both indoors and out-of-doors, and can be furnished plain, printed or embossed in a variety of patterns. *Allen Hollander Co., Inc.*

P-440

FOR MORE INFORMATION on these new products use the Readers Service Card in this issue.



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For the convenience of users, the names and addresses of suppliers, formerly included at the end of each individual section, have now been consolidated into one complete alphabetical list. Sales and export offices, where furnished, are shown in a number of cases. Telephone numbers, too, have been included for convenience.

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THE BUSINESS OUTLOOK FOR 1961, as economists in both government and industry now see it: There will be a mild slide in the first half--by no means a slump. In the second half of the year, the easing will give way to a pick-up. Net, industrial output and total sales will come close to this year's levels. Things won't be bad, but they won't be satisfying, either.

Some experts prefer neutral labels for what they predict for next year. They like "high plateau" or "sidewise movement." But others feel the term "recession" gives a truer picture. They see unemployment, slow sales, and lower profits as 1961's key features--and the fact that there won't be much growth.

Pluses and minuses are nearly balanced, explaining current sluggishness. Here's how key determinants of trend stack up:

- On the side of strength, the big plus will be government spending. States and localities can always be counted on to keep raising their outlays steadily. But now federal spending--which fluctuates actively--is also expanding.
- On the side of softness, there'll be declines in inventory outlays and expenditures on plant. Also, consumers now seem to be curtailing their spending, particularly for durables.

Net, there's a period of doldrums ahead--not sharp decline.

CAN KENNEDY SHORTEN THE DOLDRUMS? Washington doesn't really think so. He can't get new programs rolling in time to offset the easing of early 1961. Even if he could act quickly, the economy probably wouldn't be very responsive. That's because the economy is changing, leaving behind the post-war period.

Here are some examples of changes that are taking place:

- Home-building: For much of the post-war period, making money easy and plentiful was a sure-fire means to expand activity. But now demand backlogs are no longer as pressing and, with payments so spread out, low money costs don't have the same lift.
- Consumer buying: It's not as bouncy as it has been. Folks seem to have plenty of goods and many don't like the prices.
- Plant capacity is more than enough to meet demand in just about all lines. So some businessmen are trimming capital outlays.

THE CURVE OF BUSINESS FOR 1961, quarter by quarter, as it has been charted by the economists, looks something like this:

- January-March--Total output will ease. Drops in building, investment, and exports will offset U.S. spending gains.
- April-June--Activity will fall a bit more. Cuts in consumer spending, mainly for durable goods, will be the main reason.
- July-September--Increased consumer buying will lead the way to recovery. Inventory buying and investment will turn up.
- October-December--The recovery will spread. Durables sales will perk up and business will start building up inventory.

TECHNOLOGY OF ADHESIVES AT YOUR FINGERTIPS

SERVICE

Subscribers to ADHESIVES AGE may now obtain, from one central source, technical literature dealing with all aspects of the adhesives industry. One or more of the books listed here may be of invaluable assistance to you. Look this list over and check the books suited to your needs.

- **Adhesive Bonding of Reinforced Plastics—H. A. Perry. $8.75.** Survey of the design and assembly of structures and products, particularly glass-fiber-reinforced plastic products, by means of adhesives. Gives data on equipment and methods used to produce adhesive bonded joints. ☐

- **Adhesive Bonding of Metals—G. Epstein. $2.95.** Considers adhesives used with metals, indicating when an adhesive-bonded joint is advantageous; the type adhesive to use; how to use it, and how to design the joint for optimum performance. ☐

- **Epoxy Resins—Their Applications and Technology—H. Lee and K. Neville. $8.00.** Guide to the field of epoxy resins, covering the chemistry of their preparation and applications, including a section on adhesives. ☐

- **Polyamide Resins—Donald E. Floyd. $4.50.** Discusses in detail various important applications of the polymers belonging to the polyamide resin family and includes a comprehensive section on adhesives. ☐

- **Principles of High Polymer Theory and Practice —A. X. Schmidt and C. A. Marlies. $14.50.** Study of the principles of high-polymer theory and practice, with a section on adhesives, their applications, and mechanisms and factors involved. ☐

- **Recent Advances in Gelatine and Glue Research —G. Stainsby (Editor). $12.00.** Study of Collagen, and its protein gelatine, comprising papers and Proceedings of an International Conference of the British Gelatine and Glue Research Association. ☐

- **Vinyl Resins—Mayo Smith. $5.75.** Surveys applications of vinyl resins with information on their types, properties, chemistry, manufacture and fabrication. Includes information on several types of adhesives in this category. ☐

- **Epoxy Resins—Irving Skeist. $5.50.** A chapter on adhesives is included in this complete study of the entire field of epoxy resins. The author gives formulations, trade names, methods of manufacture and applications. ☐

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THE BROAD INDICATORS OF BUSINESS IN 1961, as the economists see them, will come close to figures for the current year. Here's how they'll look:

-Gross National Product--total output of goods and services--will run from $505 to $510 billion in 1961. The '60 total will be $504 billion. The 1961 figure reflects price rises.
-Industrial production will fall 5% or 6% from now to Spring. Then, it will bounce back by as much during the second half.
-Employment will decline by 700,000 in the first half, before it turns up. But unemployment will continue quite large.
-Personal income will edge up 2%, because of deferred wage increases. That's one reason consumer spending will rise.

YOU'LL SEE HIGHER PRICES IN 1961, but the increases will be moderate. At the consumer level, the over-all index will be up 1½%--and could go higher. The gains will stem from special situations, rather than inflation pressure. Foods are heading upward. Services will continue their long-term uptrend. Housing costs will edge up. One of the few key declines will come in autos. At wholesale, the index will increase by nearly 1%, the experts say. Farm prices will rise in the first half; metals and machinery will go up later.

INCREASES IN WAGES IN 1961 will come very close to this year's hikes. Average hourly pay in manufacturing will rise 8¢ per hour. (This year? 8½¢.) Several million workers in unions are already assured of this much of a gain under deferred wage-increase clauses written into contracts during past years. But the unions will be on the defensive in many industries in 1961 bargaining. Management has been stiffening its attitude, spurred by growing competition.

CREDIT WILL EASE A LITTLE MORE NEXT YEAR. There'll be more money for loans and its cost seems likely to be lower. But don't look for very much in the way of big cuts in rates, even considering that President-elect Kennedy came out for easier money. Rates will ease ¼ to ½%, then level after midyear.

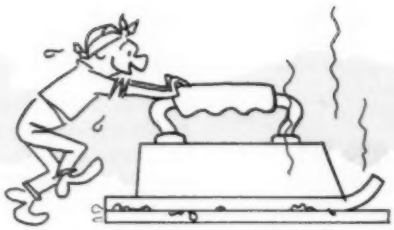
Next year will see another decline in corporate profits, from this year's $45 billion (before taxes) to around $42 billion. Production and sales will hold up, but costs will increase.

NOW FOR SOME CLOSER LOOKS AT SPECIFIC INDUSTRIES next year. Most lines will follow the general pattern--lagging in the first part of the year and then picking up. Sales gains will be modest, with increases in prices accounting for some of the rise. You will probably see few price declines.

SPENDING FOR NEW CONSTRUCTION WILL INCREASE SOMEWHAT during 1961--more in dollars than in physical volume. Value of work put in place will be up about 4%, to about $57.3 billion--from $55.1 billion of the current year. Public spending by federal, state, and local governments will increase 5%. (It is down 1% this year.) Public housing and road work will lead the rise. Private outlays will be up 4%, after slipping 3% during the past year. Easier money will lift new home starts only 50,000 from 1960's 1.3 million.

-Lumber: Sales will rise 4-5%, led by plywood and hardboard.
-Asphalt products: Off this year, sales will increase 6%.
-Flat glass: Sales fell in 1960, but will rise 5% in 1961.

HOT MELT



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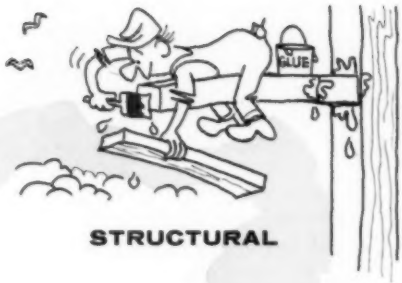

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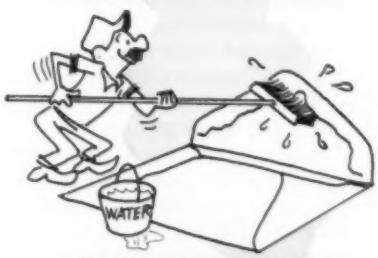

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Export—Industry's Stepchild. Almost all foreign businessmen visiting the United States admire their American colleagues for the excellence and thoroughness of our commercial attachés and their staffs assigned to foreign countries. Frankly speaking, they envy us for the wonderful service that is available not only to every American citizen, but to many visitors to our country. Even a very small manufacturer of leather goods in Offenbach will, prior to his business trip to the United States, alert all the Consulates in the American cities he intends to visit in order to obtain the most complete list of potential customers, retailers, wholesalers, brokers, and a list of probable representatives who will be best suited to carry his line after he has returned home. Furthermore, he will require all information concerning customs duties and other regulations; he will expect the various Consulates to supply him with a number of competitive catalogues and price lists; he is looking forward to meeting an expert in his line, in every one of these Consulates; someone who will be able to advise him in every respect so that he is sure to wind up with the largest possible amount of orders and an almost tailor-made network of representatives.

Consular officers whom this writer has met, have frequently complained about the almost unbearable insistence of their countrymen. They point out with some annoyance that their American colleagues in foreign countries are rarely honored by the visits of American industrialists or businessmen. Although America is probably the only country in the world which spends a tremendous amount of money on an excellent organization and network of commercial intelligence—the American citizens engaged in industry and commerce barely take notice of the splendid spadework the American Government is doing.

This writer has been in close contact with the New York field office of the U. S. Department of Commerce in the Empire State Building in New York City. In previous issues we have pointed out that the excellent facilities of the New York field office make it very easy for every industrialist who is interested in exporting his line, to obtain a galaxy of information to start his export efforts. Nowhere in Europe where we have previously traveled widely, nor in France, Switzerland, England, Germany and other countries, did we find organizations which provide the vast amount of information covering foreign markets as we did right here in the United States. In order to obtain a complete picture of all efforts made by our Government for the promotion of our exports, we recently visited the Department of Commerce and other Government Agencies in Washington. Frankly speaking, we were not only amazed and astounded, but overwhelmed by the tremendous amount of work the various Government Agencies have done in order to facilitate the export endeavors of every American businessman.

The dynamic director of the Office of Trade Promotion in the U. S. Department of Commerce in Washington, E. E. Schnellbacher, points out that foreign trade in the United States amounted to $32 billion in 1957. Of this large sum, $19.5 billion represented the value of our non-military exports. This sum exceeded total consumer purchases of automobiles, parts and accessories in the United States. It was greater than the receipts of our farmers from the sale of either their livestock or their crops.

American foreign trade of this magnitude has given us a dominant position in global trade—a position being seriously challenged, as is to be expected, by the industrialized nations of the free world now wholly or substantially recovered from history's greatest war and threatened by the economic drive of the Soviet bloc.

We must revise our concept of export trade—We no longer regard it as a pleasant bonus to be added to America's domestic profits. We are skillful in meeting competition here at home; we must be at least equally skillful in meeting the foreign threat. The responsibility for developing American international trade cannot be left solely to our largest firms; more medium and small-sized businesses must enter the competition.

Very few people realize how many countries in the world are interested in American products. Recently the Bureau of Foreign Commerce published a list captioned "Possibilities for Expanded or New U. S. Export Markets Reported," pointing out that in 30 geographic areas potential markets for U. S. products exist. Among the listing of "Chemicals" and "Allied Products" we find the following countries which have expressed an interest in adhesives and related products: Australia, Chile, Burma, Ecuador, Greece, Italy, Korea, Kuwait, Mexico, Morocco, Norway, Pakistan, Portugal, Saudi Arabia, Sudan, Switzerland, Turkey and others.

Based upon the information this writer has obtained through the unusual cooperation of all members of the various departments, we will give now, step by step, the procedure for even a very small manufacturer of either raw material in bulk or manufactured goods.

On The Continent (cont'd)

If he calls personally on any one of the 33 strategically located field offices of the Department of Commerce, he will meet an expert who will advise him on every detail concerning the projected export drive. He will be shown trade lists containing principal importers, processors, wholesalers, distributors, sales agents and service organizations grouped by country and individual commodity and information about relative size, type of operations, sales territory covered and other details indicated. Furthermore, World Trade Directory Reports are available, giving more details concerning a particular company. If more information is desired, the manufacturer can advise the field officer that he would like to visit the Department of Commerce itself; he will be introduced by individual letter to important people in the department and will receive the most cordial and elaborate briefing concerning his export endeavors in Washington.

Needless to say, every American businessman can also communicate by letter with the field offices or the Department of Commerce in Washington, D.C. In some instances it is possible to obtain a clear picture of potential markets, their importance and all other details, such as customs duties, transportation, letters of payment, credits, credit insurance, etc., during one visit lasting about an hour.

In order to obtain more detailed information and the judgment of an interested but unbiased party, letters should be addressed to our Commercial Attachés who are attached to almost all American Embassies in the entire world, and to other Consulate Generals in countries where no American Embassy has been established.

What does the Commercial Attaché do? He develops a great variety of activity stemming primarily from requests for trade information received from American business and from the Department of Commerce. Assisted by the local staff, he gathers much of the basic information for commercial reports, such as World Trade Directory Reports, Trade Lists and Market Surveys. He constantly develops new trade leads for American business—which involves maintaining a wide variety of contacts in the local business community and with government.

He welcomes visits of American businessmen and assists them to locate distributors and agents for their product and he also informs the Department of Commerce of foreign businessmen's visits to the United States. He keeps in touch with local government officials in order to keep abreast of developments in trade policy. He travels extensively throughout his district and appears at business luncheons in clubs to give talks designed to provide better trade relations for the United States.

He works closely with American Chambers of Commerce and with local representatives of American firms on problems of mutual interest; he helps visiting U. S. trade missions; assists in setting up trade fairs in which the United States Government participates; he makes sure that American businessmen's inquiries about trade connections are brought to the attention of the local business community; and he reports on commercial and trade matters, and contributes to general economic reports from his post.

Figuratively speaking, our Commercial Attachés have taken off the striped trousers and exchanged the cut-away for a business suit; they have been instructed to get out and "beat the bushes" for new possibilities for sales of American products. It is true that they do not carry an order book in their pockets, but they can, and do, uncover potential trade opportunities and report them to Washington for dissemination to American industry and business.

This is the man to write to and give all the details on the projected export endeavor, including, of course, leaflets, catalogues, prices and if possible, some samples. A number of our business friends have been amazed at the speed and accuracy of the answers which they have received from even very distant parts of the world; they have very high praise for the efficient work of our Commercial Attachés.

All the information obtained thus far should be reviewed once more with either a Field Office or the Department of Commerce in order to fill in certain details; afterwards a decision is made whether the company itself will pursue and develop the export markets, or whether it will turn over the information and export business to a suitable exporter. During the past few months, special conferences on export trade promotion have been arranged by the Department of Commerce, Business and Defense Services Administration with quite a number of industries. It is interesting to excerpt a few details from a report covering a conference with Chemical Specialties Industries which was held on July 19, 1960, presided over by H. Herbert Hughes, deputy administrator of the Business and Defense Services Administration. Walter Mannheimer, vice-president of the Miranol Chemical Company Inc., Irvington, N.J., manufacturers of synthetic organic detergents for all industries, points out that "while there are, undoubtedly, a number of steps which the Secretary of Commerce and his staff could take to assist American industry in the development and expansion of foreign markets, it is my belief, based on almost twenty years of experience in foreign trade, that the most important changes are required right here at home."

ADHESIVE BONDING OF ALUMINUM

Because requisite lighter weight, lower cost, smooth-surface metal assemblies could not be attained with mechanical fasteners, researchers focused their attention on adhesive bonding. This impetus, combined with recent developments in polymer chemistry and the commercialization of many new synthetic resins, gave rise to a quantity of new adhesives for metal-to-metal bonding.

Aluminum permits full utilization of these recent adhesive advances. As a result, the bonding of aluminum to itself and to other materials has become very prominent in the last few years. In many cases where the expense of riveting or welding has prohibited an aluminum application, adhesives offer a considerable decrease in fabrication cost, thereby placing aluminum in a competitive position with other materials.

Proprietary adhesives now available will give satisfactory aluminum bonds for many applications. The selection of the proper adhesive is primarily a process of evaluating several likely adhesives against the known or projected requirements of a specific application.

In addition to the large number of suitable adhesives, there are also many methods of bonding, plus a variety of curing schedules. This versatility offered by the adhesive bonding technique is the reason for its expanding use with aluminum. Low cost and the simplicity of bonding also contributed to this success.

Aluminum applications based on adhesive bonding include cross members in box cars, sandwich panels with honeycomb cores and aluminum skins, louvers and awnings, portable poster signs, beach umbrellas, curtain wall construction with aluminum corrugated cores, evaporator and condenser joints in refrigerators, etc.

Bonding aluminum to itself and other materials offers many advantages that are of interest to designers and engineers. The majority of these features result from the inherent nature of the process itself, in conjunction with the mechanics of the particular joint designs employed.

Adhesive bonding makes possible the joining of dissimilar metals with the minimum amount of bimetallic corrosion. Since the adhesive tends to serve as a continuous barrier between the two metals, the extent of galvanic corrosion is lessened. In addition, the possibility of entrapping moisture between the faying surfaces is eliminated.

Because of the continuous joint, adhesive bonds distribute stress loads evenly over the entire joined areas and permit the use of lighter gage aluminum. Most adhesives tend to absorb or dampen vibration or shock. The design engineer can therefore reduce costs and weight while increasing joint strength and rigidity.

Since adhesive bonding provides continuous contact between mating aluminum surfaces, the process actually seals while it bonds—thus eliminating the cost of separate operations and permitting the sealing of joints where it might not otherwise be possible. A sound metal-to-metal bond is usually impervious to both liquids and gases and some adhesives act as electrical insulation.

By EDWARD D. GARDNER
Structural Testing Director
and
ROWLAND W. FLOURNOY
Project Engineer
Reynolds Metals Company
Richmond, Virginia

Adhesive-bonded metals form smooth, protrusion-free joints which improve the aerodynamics of exterior surfaces by eliminating gaps, bulges, and external projections. Metal-to-metal joints also maintain the original strength of the structural members since both holes for the insertion of fasteners and countersinking to achieve a flush surface are unnecessary. In addition, adhesives eliminate the excessive heat required in welding or brazing operations that tend to reduce the strengthening effect of previous heat treatment, or of cold working.

Production Problems

Despite all the aforementioned advantages of adhesive bonding, some production problems may arise. Special equipment may be required, and extreme care must be exercised to ensure that joint surfaces are clean and that proper heat and pressure cycles are applied. Structural members should probably be redesigned, since adhesives seldom show their best properties when substituted directly for mechanical fasteners.

An adhesive-bonded joint derives its strength by utilizing a larger contact area than joints of other types. Consequently, the greatest strength is obtained in a metal-to-metal adhesive joint if the maximum amount of bonded area is put to work.

Theoretically, the entire joint is stressed if it is designed properly. Sufficient faying surface area must be designed into the joint to produce the required strength. When it is not possible to design for the best joint geometry, the adhesive selected should be one that performs best under the type of stress to be encountered in the particular application.

The adhesive which produces the strongest bond in tension or shear, will not necessarily yield the highest strength in peel.

With tensile or shear loading, the more rigid adhesive will offer the greatest strength. However, when the joint will be subjected to flexure and shock loading, a compromise in ultimate strength must be planned to obtain a degree of resiliency for withstanding the dynamic loading.

Peel-loaded joints will be stronger if the adhesive has some elasticity. When a brittle adhesive is used on a peel-loaded joint and the load stressed to the critical point, the bond will fail progressively since the brittle adhesive fractures readily. Elastic adhesives are superior in peel because, in stretching under stress, they tend to widen the line at the load-carrying edge. This results in the distribution of the load over a larger area.

Dissimilar metals with widely differing coefficients of expansion can present a problem, if the adhesive selected is not sufficiently elastic. As temperature changes occur, a brittle adhesive may develop internal stresses strong enough to destroy the bond or warp the assembly.

If a joint is loaded entirely in tension, the forces act in a direction perpendicular to the plane of the joint. However, precautions should be taken with this type of loading because two things can happen while the joint is under high stress: the forces may not remain perpendicular to the plane of the joint; or, where thin sections are involved, one or both of the adherends may tend to bend or twist. In either case, it is possible for the forces to resolve themselves into cleavage or even peel which will impose severe localized loading on a joint designed for uniform tensile loading.

Meticulous care must be exercised in making tensile-loaded adhesive joints in order to achieve uniform strength over the entire faying area. Any area of low strength, particularly if located near the joint edge, can readily induce a condition resembling cleavage and invite rapid failure.

Unsuited For Butt Joints

Adhesives are not readily suited to a butt joint design. When two metal rods are butt jointed any bending of the rods resulting from leverage will exert tremendous cleavage forces that will result in joint failure.

Stress direction is parallel to the plane of the joint in shear loading. This is the most efficient and most reliable type of joint for adhesive bonding.

Wherever possible, the joint should be designed for shear loading. However, there are two factors which can impair the strength of such a joint. If the metal adherends are completely rigid, an element of cleavage is induced as stress is applied—unless the joint is so designed as to balance out these forces. When the joint sections are thin, the metal may progressively deform under severe loading until the edges are subjected to some peel stress—unless the joint is designed to avoid this effect.

With cleavage loading on a joint, the forces react somewhat differently. The action here is similar to that of opening a book. As the force is applied one near edge or side of the joint undergoes great stress whereas the remainder is under little or no load at all.

The mechanics involved in this situation are very similar to those that would be prevalent if one side of the joint were hinged. A theoretical stress diagram would show the unit stresses increasing from zero on one side to infinity on the other. Consequently, not all of the adhesive in the joint is contributing its share of strength.

Peel loading is the least favorable situation of all, from the standpoint of strength. This type of loading can be visualized best by recalling the action when opening a sardine can by peeling back the lid with a turnkey. Consider the lid as the top section of the joint, and the can as the bottom.

In peel loading, even less of the adhesive contributes to strength than in the cleavage joint. This is because, all the stress is concentrated along a fine line at the very edge of the joint, and the majority of the adhesive in the joint is under no load whatsoever.

Ideal Joint

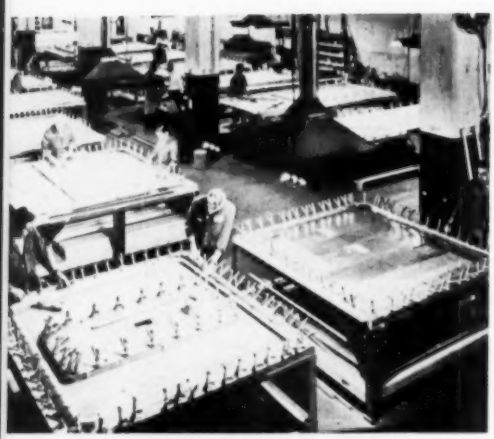
In practical applications, it is almost impossible to achieve the ideal joint in which the stresses are entirely pure tensile, shear, cleavage or peel. Usually there is a combination of several different types of stresses acting on the joint. Therefore, each joint must be designed to withstand the stresses resulting from its end use.

Essentially, all structural adhesives

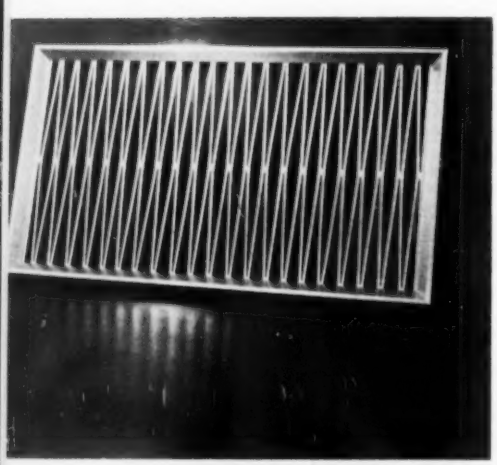
Kitchen in the Clouds

At REF Mfg. Corp., aircraft galley components are made by bonding aluminum skins to both sides of balsa-filled panels. A thin coat of sealer is applied to the end grain surfaces of the balsa to keep out moisture and act as a base for the adhesive. These Skygalleys are used on jet liners such as the American Airline 707 and the Pan American DC-8.

Corner joints of window frames and storm doors are often assembled with adhesives.



Wall panels of aluminum Helicop Huts are epoxy-bonded at Craig Systems, Inc.



Air conditioner grills bonded from aluminum extrusions at Reynolds' Experimental Center.

are resin type adhesives, as differentiated from the animal and vegetable glues, hydraulic-setting cements, and natural asphaltums which have been used for years. A familiar system for classifying structural adhesives divides resins into three categories: thermoplastic, thermosetting, and elastomeric.

The term "thermoplastic" refers to resins that soften with the application of heat, and adhesive joints formulated with these resins must be maintained under pressure to effect a bond. Polyvinyl acetate resins are an example of this type. Thermoplastic adhesives have considerably less strength than the thermosetting types. However, their lower cost makes them satisfactory for many applications where their modest properties will meet the end-use requirements.

The heading "thermosetting" comprises resins that develop full strength and harden when heated. Adhesives that utilize this type of resin normally must be cured under heat and pressure. Alkyd, epoxy, and phenolic resins can be placed in this category. Some adhesive classifications may add a sub-heading to the thermosetting group and refer to it as "catalyst setting." If this is the case, most epoxy resins will fall into this sub-heading since they often use a catalyst to accelerate their curing.

Catalyzed, cold-setting epoxy and phenolic adhesives cannot be considered in the thermosetting category because bonding is effected at room temperature. This type of adhesive consists of two or more components, namely catalyst and resin. The third component may be a promoter which modifies the catalytic action.

The thermosetting adhesives offer the highest bond strengths, but they are also the most costly. Therefore, only applications with severe service requirements warrant the use of the expensive, maximum-strength types.

The "elastomer" category includes rubber polymers—either natural or synthetic—that are used by themselves for unstressed adhesive applications, or modified with other synthetic resins to formulate an adhesive with high flexibility.

Other classification systems make use of chemical composition groups, bonding types, forms of vehicles, physical state of the formulations, and flow characteristics to assort all of the available adhesive types into categorical form.

Design engineers using adhesive bonded aluminum are primarily interested in adhesives that offer sufficient joint strength for some form of a structural application. With this thought in mind, this article will present data on adhesives that are suitable for withstanding some degree of stress. For the sake of clarity, the adhesives will be referred to in their usual chemical composition type. However, it should be kept in mind that modifications are possible within any particular chemical type of adhesive. These additives then can alter the physical properties of the modified adhesive.

Adhesives commonly used to bond aluminum include: natural and synthetic rubbers; polyvinyl acetates; alkyd, epoxy, and phenolic resins, and several formulations of phenolics and epoxies modified by vinyl and phenol additions. The rubbers and polyvinyl acetates generally are not used for structural applications where high shear strengths are required. However, they are utilized in many aluminum bonding applications such as curtain wall construction where aluminum skins are bonded to paper honeycomb, foams or other core material.

Low-Cost Adhesive

Neoprene-based adhesives of the chemically cured types, although actually not belonging in the structural category do offer good, all-around properties. Probably the most versatile of the low-cost adhesives, their shear strengths range from 150 to 900 psi and their resistance to water, chemicals, hydrocarbons, and heat is good. Discretion must be exercised in their use, however, since their ability to sustain continuous stress loads without failure is usually weak, the shear strength of neoprene adhesives are only about 100 psi for extended periods.

Two of the newest types of adhesives for structural applications are based on epoxy and phenolic resins. These adhesives offer very good shear and tensile strengths at elevated temperatures and are resistant to abrasion, sunlight, water, and most chemical solvents. They can be cured at room or elevated temperatures, with or without pressure, depending upon the type used.

Phenolic resin adhesives are generally in the form of films in thicknesses ranging from 0.003 to 0.03-inch, in widths up to 36 inches, and in any desired length. Though good structural adhesives, phenolic resins are limited in application because heat and pressure (300°F. and 150 psi) are required for curing. These

adhesives are used where high peel strengths and temperatures up to 300°F. are encountered in service.

Commercial epoxy resin adhesives are in one-, two- and three-part resin systems. The one-part epoxy resin system consists of a paste or putty, heat-cured at temperatures from 275° to 500°F. This adhesive requires no mixing, does not set up or harden until heat is applied, and requires only contact pressure for bonding. It is used where temperatures up to 300°F. are encountered in service.

A Two-Part System

The two-part epoxy resin system is composed of resin and catalyst, the catalyst being mixed with the resin at the time of application. This resin is usually cured at room temperature and reaches maximum strength in four to seven days. Curing time can be shortened considerably by the use of heat, with the time at temperature depending upon the adhesive used. At 300°F., usually one to three hours are required for a complete cure.

The consistency of this adhesive varies from a thin syrup to a heavy paste. It will begin to harden about one hour after the addition of the catalyst and only the amount that can be used within this period should be mixed at one time. Mere contact pressure is sufficient for bonding.

This formulation is used primarily for structural and non-structural applications subject to normal temperature conditions. A 50 per cent loss in strength can be expected at 180°F. Many catalyzed, cold-setting epoxies can be cured in one to 24 hours.

Three-part epoxy resin combinations consist of a resin, a catalyst and materials such as talc, Cab-O-Sil, aluminum powder or asbestos which serve as the filler to control the viscosity for particular applications.

This factor is very important when the adhesive is used for gap filling or where the parts being assembled have large clearances. Like the two-part system, this adhesive will begin to harden within one to three hours after the catalyst is added; it requires only contact pressure for bonding. The curing schedule also is identical to that of the two-part resins.

In selecting an adhesive, it is necessary to know the physical properties required and the service conditions to which the joint will be subjected. Proper choice of the best adhesive for a new application will involve several factors:

(1) Materials being bonded. The adhesive must wet the surfaces and adhere to them.

(2) Joint design and the initial level of strength required. Shear, tensile, cleavage, and peel forces must be evaluated.

(3) Service life expected of the bonded joint. The adhesive bond may need resistance to heat, moisture, oils, hydrocarbons, other chemicals or fatigue.

(4) Working properties and bonding requirements of the adhesive. Methods of application, temperature and pressure required, and speed of curing are essential factors for economical production. Adaptability of the adhesive process to existing bonding equipment and the need for additional equipment must be considered. The size of the production run will influence the decision as to the need for special process equipment with a particular type of adhesive. Personnel requirements for production and inspection also may differ for the various bonding processes.

(5) Cost. This factor includes cost of adhesive, preparation for use, the bonding operations, waste, and rejects.

Service Requirements Vary

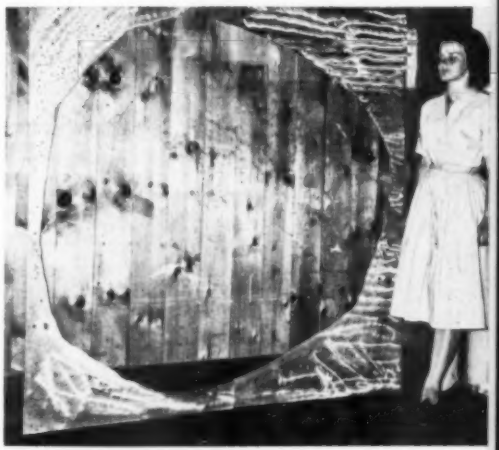
The service requirements for adhesives vary so widely that it is impossible to select a general adhesive which could be used for all applications. One application might only require a 50 psi shear strength whereas another might require 4000 psi.

As a general rule, cost increases with increased bond strength. The price range for a low strength epoxy adhesive is about $7.00 to $8.00 per gallon. As the strength increases, the price increases up to $50.00 per gallon.

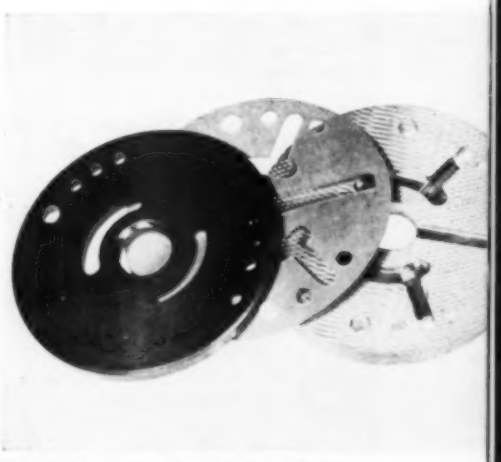
One of the most critical factors in the use of adhesives is the relatively short period of time that the material can be stored without destroying or at least impairing its value as an adhesive agent. This is especially true for the one-part systems in which the resin and catalyst come premixed from the manufacturer. With some of these adhesive products, shelf life is measured in terms of days.

In two-part systems, mixed by the user before application, the shelf life of the compounds is lengthened considerably. However, these materials require special mixing equipment when used on large scale production

A 14-foot aluminum runabout was adhesive-bonded at the Reynolds' Experimental Center.



Tempered plate glass cemented to aluminum is the dominant panel of KLM's light mural.



Powdered iron disc is bonded to a die cast aluminum plate to make rotor end plates.

runs to insure that the applied mixture is homogeneous. Generally, these materials have an exceptionally short pot-life—sometimes a matter of minutes—once they are mixed.

Production scheduling and control become factors of paramount importance for the manufacturer using large quantities of expensive, high-strength adhesives. If a tight production schedule is not maintained in these applications, an excessive number of rejects will probably result.

In most cases, solvent degreasing to remove the oil film is all that is necessary to obtain good joint strength when using adhesives with aluminum. However, if their surface has a heavy oxide coating, wire brushing or sand blasting may be required. For applications requiring maximum strength, it is necessary to chemically pretreat the aluminum with a chromic-sulfuric acid bath or dip. The recommended procedure for this chemical pretreatment is as follows:

(1) Degrease the assembly with trichloroethylene.

(2) Immerse for 20 minutes in an agitated bath at a temperature of 150°F. containing 24 parts of concentrated sulfuric acid, 7.5 parts of sodium dichromate, and 68.5 parts of water by weight.

(3) Rinse in clear running water.

(4) Air dry at room temperature.

(5) Oven dry at 150°F. for 30 minutes.

In many applications, parts to be bonded may have anodized surfaces. This is a very good bonding surface and maximum strengths can be obtained without additional treatment —providing the surface is free of dirt or grease. Excessive fingerprints, on the surface, can be wiped clean with a solvent such as chlorothene.

Phenolic resin films are supplied in rolls. They can be cut to any desired length and laid between the parts to be joined. Manufacturer's recommendations concerning the required amount of heat and pressure for curing should be followed closely.

Epoxy adhesives may be applied by roller coating, caulking gun, brush, putty knife, or spray nozzles. The application method will depend largely on the design of the joint and the size of the production run. Automatic dispensing equipment is available for mixing the two-part resins and metering the exact quantity for each application.

Roller coating is fast and economical where continuous production runs on aluminum sheet are involved. When the bead or ribbon of epoxy must be placed accurately, the use of caulking guns is advantageous. Brush coating is applicable to small or irregular parts, or where the volume does not warrant investing in more elaborate equipment.

The use of adhesives for bonding aluminum often requires jigs, fixtures or presses to hold the assembled parts in place while the bond sets. Pressures should be applied evenly to all portions of the bond area by these holding devices. Where heat and higher pressures are needed to cure the adhesive, the jigs and fixtures may be placed in ovens or autoclaves, or both heat and pressure may be applied through the use of a press with heated platens.

Adhesives Commonly Used in Bonding Aluminum

Type of Adhesive	*Customary Bonding Methods*	*Normal Curing Time*	*Structural Applications Performance*	*Typical Applications*
Synthetic rubbers	Pressure Solvent release Vulcanization Water evaporation	Room temp. 24 hr. 260° to 350°F. 5-30 min.	Poor	Aluminum to fabrics, foil, plastics and rubbers.
Polyvinyl acetates	Reactivation Solvent Release Water evaporation	250°-350°F. 3 sec.	Poor	Aluminum to aluminum, ceramics, cloths, cork, glass, leather, paper, plastics and wood.
Alkyds	Contact pressure Room temp.	10 min.-24 hr.	Fair	Aluminum laminations, sealer.
Phenolics	Heat and pressure	5-10 min.	Good	Aluminum to aluminum, glass and wood.
Phenolic-vinyl	Heat and pressure	5-45 min.	Excellent	Aluminum to aluminum and wood.
Phenolic-neoprene	Heat and pressure	15-30 min.	Excellent	Aluminum to aluminum, plastics and wood.
Cold-setting epoxy	Catalyst and time	1-24 hrs.	Good	Aluminum to other metals Sleeve joints in pipe.
Epoxies	Heat and pressure	10 min.-24 hrs.	Excellent	Aluminum to aluminum, ceramics, glass, plastics and wood.
Phenol-epoxy	Heat and pressure	200° to 350° F. 60-90 min.	Excellent	Aluminum to aluminum, foil and wood.

Epoxies which cure in 4-7 days at room temperature are not given here.

Chemical Reaction

All adhesives containing thermosetting resin components will develop their strength and permanence, at least in part, by undergoing a chemical reaction known as "curing." The rate of this curing reaction will accelerate with increasing temperature. The joint, of course, must be under sufficient pressure during curing to produce the flow necessary to cause adequate and uniform wetting of all surfaces.

With many adhesives, mere contact pressure is satisfactory for curing. Pressure then must be retained until the adhesive has hardened and developed strength to resist stresses after the assembly is removed from the press or clamping fixture.

The best method of curing phenolic films is through the use of an autoclave where uniform pressure and heat can be applied simultaneously. With phenolics, the cure schedule may be varied over a temperature and time range of 275°F. for 480 minutes and 350°F. for 50 minutes under pressures from 75 to 200 psi, depending upon the end-service requirements.

Strength Range of Adhesive Bonds in Aluminum-to-Aluminum Joints

Type of Adhesive	*Normal Cure Schedule*	*Approximate Tensile-Shear psi*
Natural and synthetic rubbers	Dry 1 hr. at 150°F. 5 min. at 300°F. with 300 psi	1100
Polyvinyl acetates	Solvent release 240°F. for 5 min. 350°F. for 2 sec.	1500
Phenolics	1 hr. at 350°F. and 150 psi	4300
Cold-setting epoxies	3 hr. at 70°F.	2000-8000
Epoxies	2 hr. at 150°F. 10 min. at 300°F.	6000-8000
Phenol-epoxies	1 hr. at 350°F.	5000-7000

Room-temperature cured adhesives reach 20 to 30 per cent of the ultimate bond strength in 12 to 16 hours and will achieve maximum cured strength in four to seven days. After the adhesive is applied, clamps or fixtures are necessary to hold the parts in contact until the initial cure takes place—usually six to eight hours. Clamps can then be removed and the assembly stored until maximum cured strength of the bond is obtained.

The elevated-temperature cured adhesives require the same type of clamps or fixtures for holding the bonding surfaces in contact during the curing cycle. With this type of resin, the curing cycle is normally from 25 seconds to three hours at the applied temperature which ranges from 180°F. to 400°F. Heat may be applied by infrared lamps or conventional ovens. If the resin has a short cure cycle, induction heating or gas-fired torches can be used in this application.

Adhesive bonding of aluminum has been of particular interest in the design of sandwich panels that have aluminum skins on lightweight honeycomb cores of aluminum foil, paper, glass fiber, or fabric impregnated with polyester or phenolic resins. Epoxy adhesives have proven ideal for honeycomb structures because of their ability to self-fillet. A bead will form on the edge of each cell in the aluminum foil core which increases the contact area when the core is bonded to the aluminum skin.

Another important bonding application is the current use of beaded aluminum panels for the fuselage of super-sonic aircraft. These panels consist of an outer aluminum skin, a drop-hammer-formed beaded innerskin and doublers—all bonded together with high-strength adhesives. Adhesives used in this application are expensive and require a very exacting production technique, but their advantages outweigh those of any other fastening method.

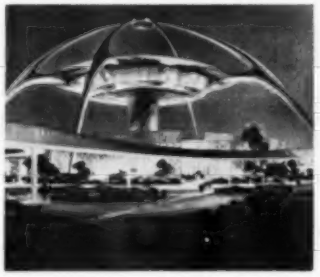
In the refrigerator industry, high-strength epoxy resin adhesives and phenolic modified elastomers are used to bond the aluminum cooling coils to the sheet aluminum evaporators of home freezers. This method of attachment circumvents the narrow temperature differential between brazing and melting temperatures. It obviates annealing that makes the metal subject to damage during handling operations. Bonding also reduces warping and buckling resulting from high temperatures and maintains the tensile strength of the aluminum sheet. Finally, it eliminates the possibility that unremoved flux may produce corrosion.

Collapse Tubing

Since the adhesive acts more as a thermal insulator than a conductor in this application, the bonding must be accomplished in a manner that provides substantial metal-to-metal contact between the tube and sheet. Sufficient pressure is used in the bonding process to partially collapse the tubing and to squeeze practically all the adhesive out of the contact area. After curing, the adhesive appears as a fillet on each side of the tube.

A recent, interesting application of adhesive bonding involves the joining of dissimilar metals for the rotor of a portable air-tool. Here a diecast aluminum plate is bonded to a powdered-iron disk facing to reduce the over-all weight of the air-powered tool.

Many companies manufacture adhesives that are suitable for bonding aluminum. Although the majority of epoxy and phenolic resin adhesives are basically the same, various manufacturers change the composition through the use of different resins, catalysts, and fillers in order to alter its physical and chemical properties. In many cases, an adhesive is tailored for a specific application.



Jet Age Structure Knit by Vinyl

The entire Theme Structure, highlight of the $50-million Los Angeles International Airport, due for completion in 1961, is knit into a single piece by a sprayed-in-place vinyl coating. The 40-mil-thick covering is waterproof, and sufficiently flexible and elastic that expansion and contraction cannot impair the structure. The material is resistant to dampness and mildew and is unharmed by contact with the soil.

The building itself is a fanciful construction of steel and concrete overlooking the 3,000-acre field. It consists of two great parabolic arches, whose legs lightly touch the ground across a diameter of 340 feet. Suspended from the arches is a 100-foot diameter saucer of glass, steel and concrete, that provides luxurious dining and observation facilities.

The most surprising purpose of the buildings vinyl coating is esthetic in nature. The coating is so thick that the texture of the structure becomes that of the vinyl. The grain, form marks and other imperfections in the concrete, and weld lines and other evidence of joints in the steel, are thoroughly concealed.

The vinyl coating for the Theme Structure was applied by the APC Liquid Envelope Process, a controlled application system of Architectural Plastics Corp. of Los Angeles. The coating is produced by Better Finishes and Coatings, Inc., Newark, N.J., and is based on stabilized vinyl chloride-vinyl acetate co-polymers supplied by Union Carbide Plastics Co., New York, N.Y.

The Development of Autoclave Bonding of Metal Subassemblies in the British Aircraft Industry

Massive tooling requirements for curing complex curved assemblies in flat-platen presses led to extensive research of various methods making use of fluid pressure

About 1947 the British aircraft industry started using metal bonding techniques for bonding structural metal parts of aircraft.

Although some use of such process had already been made by that time, very little information had been published. However, the development work carried out by Bristol Aircraft Ltd., soon established that bonding methods had very well defined advantages. These advantages can be summarized very briefly as follows:

(1) Complicated shapes made without machining or removal of the cladding from aluminum-rich alloys.

(2) Smooth external finish, free from rivet patterns.

(3) Increased fatigue life by the removal of stress-raised focii such as holes for rivets.

(4) Easier sealing for pressurization of fuselages.

(5) Simpler maintenance of structures.

(6) The possibility of using the most suitable gauges of metal to obtain the most efficient structure and thus reduce weight.

(7) Sandwich structures using honeycomb cores can be used.

In 1947, all of the adhesives which were suitable for high-strength bonds were modified phenol formaldehyde and as such required both heat and pressure for their cure. These needs had inevitably led to the use of flat platen presses for bonding parts. While very satisfactory glued joints were produced by this method, the massive tooling required for complex curvatures was not only expensive to produce but introduced problems in the uniform application of both heat and pressure.

Both these considerations led to an exploration of alternative methods for applying heat and pressure, and quite a lot of preliminary and abortive work with other methods was carried out before a study of the possibility of using fluid pressure began to show some promise. The first tests were made using a pressure box.

Somewhat resembling a heavy duty plywood press, the pressure box was used to contain a rubber bag which could be inflated to 200 pounds per square inch to press the metal parts being bonded together onto the curved die. For convenience of manufacture, dies of this type were made in zinc base alloy and were heated by conduction from the steam chest to which they were bolted and which formed the base of the pressure box.

A successful bonding of scaled down parts in this box was obtained almost at once. While it was thought that this type of equipment could be developed for larger scale use, a different development proved to be even more successful.

In this new development, the pressure bag was replaced by a vacuum bag, formed by a rubber sheet over the work being bonded. In this way, the inside of the box could be pressurized to apply curing pressure to the work. By this bilateral application of pressure, the die could be immersed in the compressing air because the air then provided both "action" and "reaction" onto the glue joint. This modification meant in turn that the die would only have to be strong enough to withstand the vacuum pressure and that the pressure actually on the glue line would be increased by the addition of the vacuum-created pressure.

In considering the best shape for the pressure box, it was at once appreciated that a conventional cylindrical autoclave might be satisfactory and for this reason a miniature unit was constructed for trials.

The change of shape introduced heating problems, but this was overcome by the use of a low voltage resistance mat fitted below the simple curing jig that was now possible. Radiation heat was used.

As in the later work with the pressure box, a rubber sheet was laid over the work being bonded to form a vacuum bag when vacuum was applied through a hole in the curing jig. Although problems were met selecting a rubber sheet capable of withstanding the 302°F. curing temperature being used, and in sealing the electrical leads against pressure, these difficulties were eventually overcome and a very satisfactory technique evolved.

On the basis of this success, a much larger autoclave was built so that full scale development could begin. This large autoclave was six feet long and three feet in diameter. It was fitted with a conventional quick release serrated ring door. A novel feature was that the door was mounted on a trolley so that it could be inserted or removed from the

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Technical Manager
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mouth of the autoclave and pushed to one side on rails to leave the entry free during loading or unloading operations.

At the time this autoclave was commissioned, bonding pressures of the order of 200 psi were in use although subsequent experimental work reduced this pressure to 100 psi. The 200 psi pressure was obtained by charging a similar volume high-pressure cylinder with the 90 psi air available from the works air lines and then boosting this compressed air to the higher pressure needed for charging the autoclave.

Heating in this autoclave was accomplished by woven resistance mats fitted below the curing jig. The mats were fitted on long frames about six inches wide which could be articulated to approximate the shape of the jig above them.

The curing jig itself was mounted on a trolley of angle iron which in turn ran on wheels on rails inside the autoclave when loading or unloading.

The rear of the autoclave trolley was fitted with self-cleaning bayonet fittings which made contact automatically when the trolley was pushed home in the autoclave. These contacts were connected to electrical socket outlets at the side of the trolley, so that the heating current could be fed to the resistance mats. By making some of the contacts in suitable metals, pyrometer leads could be plugged into the trolley as well and their signals relayed to a recorder fixed outside.

Control of the heating was by means of a multi-tap transformer. A further degree of control was obtained by the introduction of a Variac into the primary feed to the transformer.

As already mentioned, the heating mats could be withdrawn for use with any jig shape produced by fabricating sheet of about ⅛-inch thickness to the desired contour and then mounting the sheet on simple supports to form the curing jig.

This autoclave and a range of curing jigs was used to prepare actual aircraft structures for test and most of the bonded components in the early Bristol Britannia aircraft were in fact made in it.

As Demand Increased

As the demand for bonded parts grew, new plant space was needed and as a result of its experience with autoclave bonding, Bristol Aircraft Ltd. decided to install further autoclaves in preference to additional presses. At the time this new plant was designed, modifications were introduced to overcome some of the drawbacks experienced with the first large autoclave.

The most important change made was to heat the work within the autoclave by circulating air over heating coils or elements by means of a fan. This decision was taken to achieve a more uniform degree of heating than had been possible with the resistance mats used hitherto and also to overcome the problem associated with the burn-out of a heating mat during a bonding operation.

Apart from these important factors, there was also a need to install longer and wider autoclaves to allow more parts to be bonded at one time and to reduce the mechanical joints in structures still further by bonding larger units than had hitherto been possible.

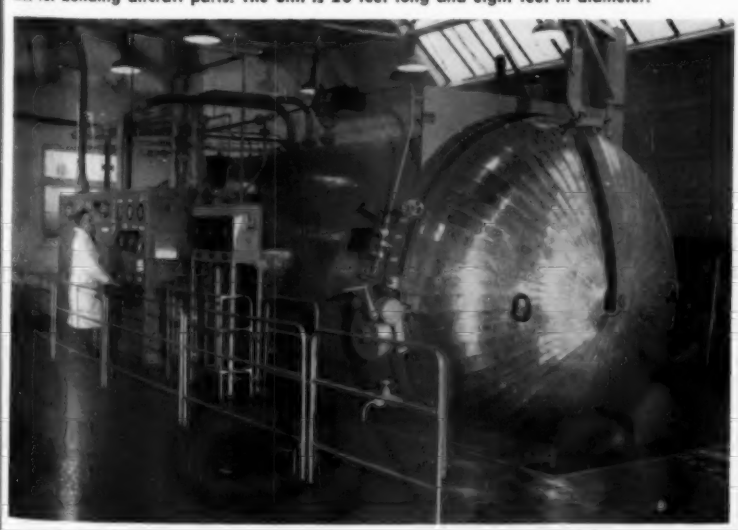
Three autoclaves of this type were designed and installed; the largest is 35 feet long and four-and-a-half feet wide. The next is 17 feet and the same width. While the third is also 17 feet long, it is five-and-a-quarter feet wide. All these autoclaves have quick release doors hung on massive hinges to open outward.

These doors cannot be opened while any significant pressure remains in the autoclave because a diaphragm-operated interlocking device prevents the rotation of the interlocking ring on the door. In addition, a further electrical contact has to be closed by the full rotation of the ring into the fully closed position before the pressure valve can be opened.

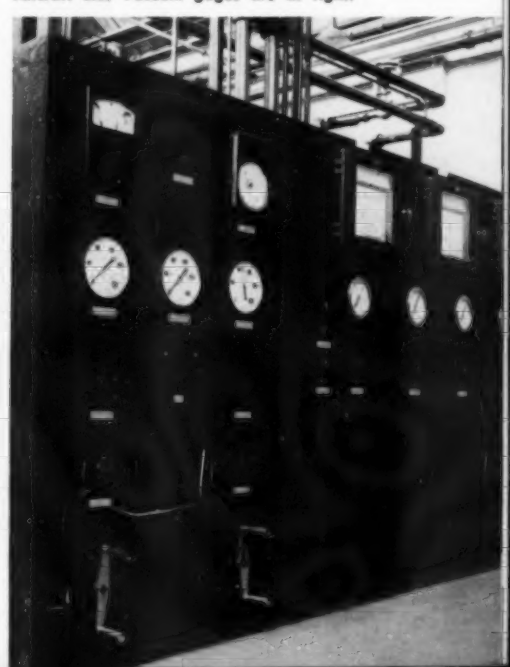
The steam coils inside the autoclave are between the walls of the unit and an internal baffle. The steam pipes run longitudinally between large circular manifolds at each end of the autoclave. By a simple valve system, the same pipes can be used for the circulation of cooling water once the cure has been completed.

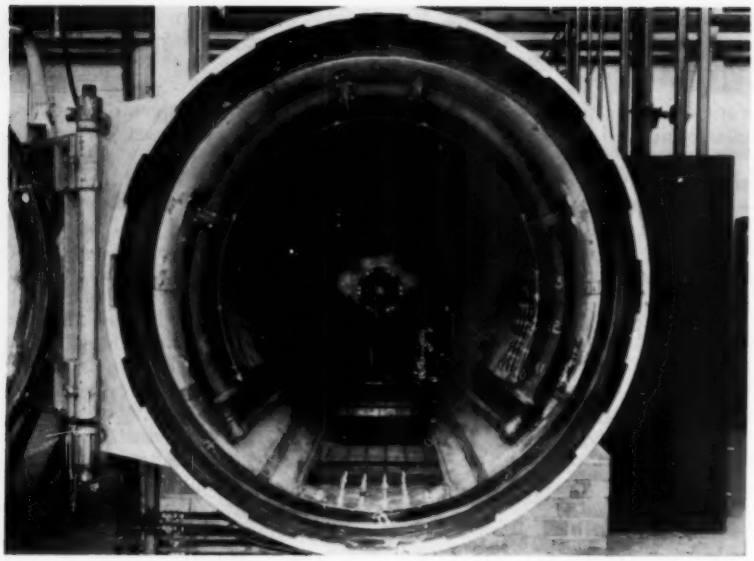
To avoid heating the mass of the autoclave—and thereby losing heat excessively by radiation—there is a

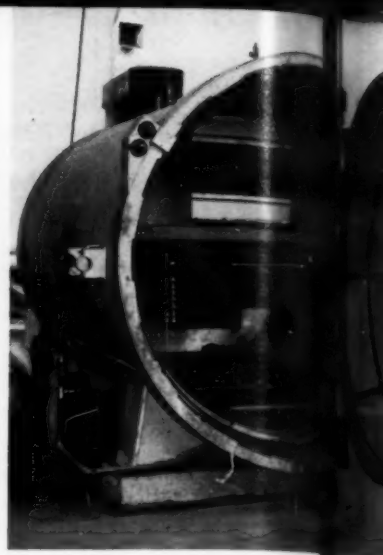
General view of the autoclave recently installed at Sir W. G. Armstrong Whitworth Aircraft Ltd. for bonding aircraft parts. The unit is 20 feet long and eight feet in diameter.



Control console for autoclaves at Bristol Aircraft Ltd. Vacuum gages are at right.







◀ 17-foot autoclave at Bristol Aircraft Ltd. View shows the heating coils, thermocouple sockets and the air circulating fan.

thick asbestos lagging on the interior surfaces of the walls and doors. This lagging also reduces the cooling time because the mass of the autoclave does not have to be cooled.

The air circulating fan is mounted in the rear dome of the autoclave and is arranged so that it pushes air along the pipes and sucks it back over the work. This fan is driven by a pressure sealed shaft connected by a multiple V-belt drive to an externally mounted five hp motor.

Vacuum for the vacuum bags on assemblies to be bonded is supplied from four vacuum pumps mounted outside at the side of the autoclave and piped into it so that a quick push-on connection can be made to the curing jigs.

As would be expected, the autoclave is fitted with a safety valve. The pressure is also recorded by means of a Budenburg recorder which meets insurance requirements and, in addition, gives a useful record of the duration of the cure's pressure cycle.

The temperature of this cure is very important and for this reason there are a number of thermocouple pick up sockets fitted at the front right hand side of the autoclave so that thin flexible thermocouples can be placed in contact with the work being bonded and the signal fed to automatic temperature controllers mounted externally in the control console.

Apart from steam and cooling water control valves, a typical console panel has three pressure gages to show the pressure in the works air supply line, the air pressure within the autoclave and the pressure of the steam supply to the autoclave. A Drayton regulator and controller is mounted above the pressure gages so that the steam pressure to achieve the temperature for curing is maintained automatically once this device has been preset.

As already mentioned, the air pressure within the autoclave is recorded automatically, as is the temperature at selected stations on the work. In addition, temperature within the autoclave is recorded by Kent potentiometric recorders on strip charts. Each recorder has a six-pen system so that the temperature at up to 18 stations can be measured and recorded.

Four Vacuum Supplies

Four separate vacuum supplies are available. The gages showing the vacuum in each line are mounted below the temperature recorders together with the electrical controls and indicator lamps for each of the four vacuum pumps.

One further set of push button controls is for the pump and fan of the Visco forced-air water cooler installed outside the building. It is through this Visco unit that the cooling water from the autoclave is circulated to form a closed cooling system.

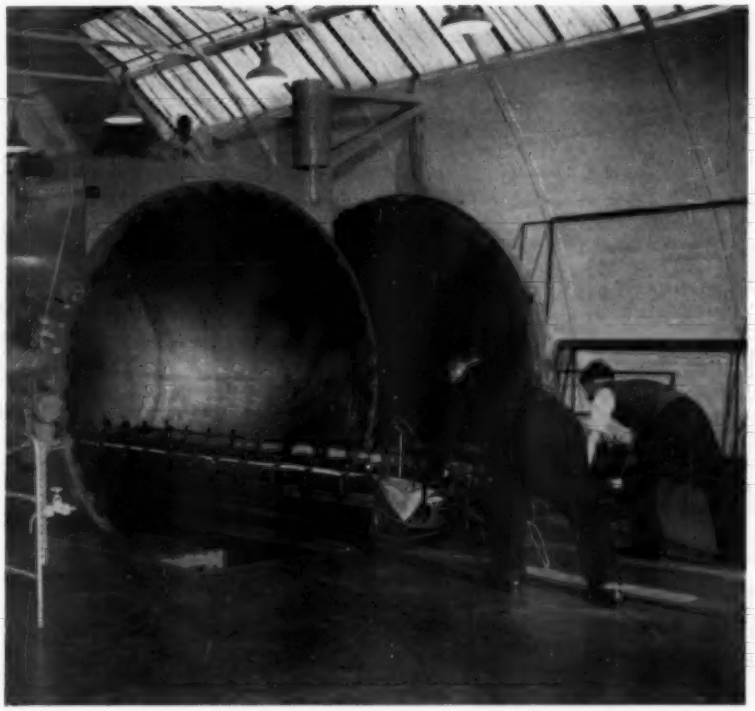
One further and interesting development at Bristol Aircraft Ltd. has been the modification of an autoclave for electrical heating. In this way the unit can be used whenever steam is not available. At the same time, it provides a much wider working space inside the autoclave by dispensing with the heating and cooling coils.

In the electrically modified autoclave, the upper portion has been partitioned to form a heating chamber in which a 40 K.W. bank of rod type electrical heating elements are installed. These elements run as black body emittors because air is constantly being drawn over them by the circulating fan—which for convenience is fitted horizontally with its driving motor attached to the top of the autoclave toward its rear.

The air is cooled by drawing it through a bank of finned coils and by circulating cooling water through these coils at high speed. The control of this type of autoclave is very simple as the temperature of the air can be preset very accurately by the use of thermostats fitted downstream in the airflow from the heaters. If necessary, some further control is possible by using the cooling water circulation as a proportional control device.

Owing to the limited amount of space and the standby duty of this autoclave, only one vacuum pump and multi-point temperature recorder has been fitted. As in the steam-heated autoclaves, the autoclave is lagged internally to reduce heat losses and to accelerate cooling. It is also fitted with a quick release door and safety devices.

▲ Electrically heated autoclave at Bristol Aircraft. Curing space is at bottom and the heating and cooling chest at the top.



▲ A view of the autoclave at the Baginton Works of Sir W. G. Armstrong Aircraft Ltd., with the door opened to the side. The loading operation of the unit is shown being demonstrated. The autoclave is mounted in a shallow pit so that the work trolley can be run directly into the unit. A pivot arm is used to suspend the autoclave door.

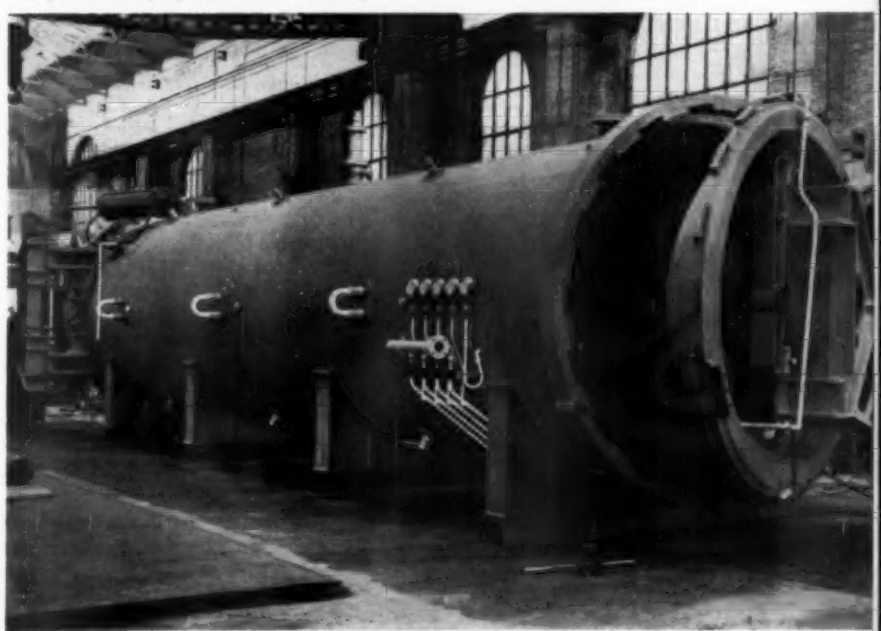
The use of autoclaves for metal bonding has now become widespread. One development has been the use of high-pressure dry steam to provide both the pressurizing medium and heating for the cure. Autoclaves of this type have been used by the English Electric Company Ltd. and also by Vickers Armstrong (Aircraft Ltd.). While this type of autoclave permits the use of a much quicker heating up sequence in the curing cycle, there are a few drawbacks.

The principal problem is the limitation on the pressure that can be applied if overheating of the adhesive is to be avoided when using steam alone. This difficulty can, of course, be overcome by using pressurized air as an auxiliary to the steam. In any case, air has to be available because pressure on the work can only be maintained during the cooling sequence by bleeding in cold air as the autoclave and its contents cool once the steam has been shut off.

Cooling this type of autoclave is sometimes assisted by cooling coils fitted around the inside of the autoclave shell in the same way as the heating and cooling coils already described. Consideration has been given also to the possibility of spraying cooling water onto the outside of the autoclave, but the stresses set up, and the possibility of corrosion of a pressure vessel, more than offset the advantages of this technique.

One of the largest autoclaves produced for metal bonding was built by Foster Yates & Thom Ltd. for

▼ This autoclave at Canadaire Ltd. is 45 feet long and is probably one of the largest used so far for metal-to-metal bonding. It has doors at each end to speed up loading and unloading operations. It provides 1760 cubic feet of working space. Doors are hinge-mounted and pneumatically operated. (Photo courtesy of Foster Yates & Thom Ltd.)



use by Messrs. Canadair Ltd., in the metal-to-metal bonding plant used for their C.L. 28 aircraft.

This autoclave is 45 feet, nine inches in length and with its diameter of nine feet, two inches provides a working space of 1760 cubic feet. Because of its length, it was fitted with a door at each end to facilitate rapid loading and unloading. Loading is done at one end as the bonded components are being withdrawn from the other. For convenience these doors were hinge-mounted and open and close by pneumatically operated ram mechanisms.

Axial Flow Fan

This end door was fitted with an axial flow fan driven by the motor mounted on the door. Like the other, it was convex in shape with the dishing inwards instead of outwards as in the more conventional autoclave. Its shell had the circumferential seams automatically welded and was designed to withstand the 200 psi bonding pressure of the Bloomingdale F.M. 47 adhesive system used by Canadair Ltd.

One of the most recently installed autoclaves in Great Britain is used by Sir. W. G. Armstrong Whitworth Aircraft Ltd. for bonding a wide variety of the parts used in their A.W. 650 aircraft better known as the Argosy. Made on the continent, this autoclave is 20 feet long and eight feet in diameter. It is mounted in a shallow pit so that the work trolley can be run directly into the autoclave. The door is suspended from a pivot arm instead of from the more usual hinges and allows the complete width of the autoclave to be available for loading when the door is opened to the side of the autoclave.

Heating and cooling coils have been grouped at one end of the autoclave, thus giving a greater width for the working space than would have been possible with the circumferential arrangement previously used. Baffles have been provided at the top and bottom of the autoclave to form a heating chest for the work and two feed channels for the hot air which can be heated to 180°C.

Metal-to-metal bonding by the autoclave technique is also used extensively by both Short Bros. & Harland Ltd. and by Fokker Aircraft. The latter company introduced some novel ideas in developing the process for use in constructing their Friendship aircraft.

Of particular note is the substitution of thin aluminum foil for the usual rubber of the vacuum bag. To allow the use of this foil on curved surfaces, Fokker also uses a bonding box in which the pressure is transferred to the work by means of fine gravel or flexible sand bags. This bonding box is an open-top box with the work laid flat on its bottom or on a removable tool in the box. The box is then filled with the gravel, covered with a strong very open-weave fabric and the aluminum foil is then laid across the box and clamped to the sides. Vacuum and pressure can then be applied in the usual manner.

In an analagous manner, ¼-inch diameter balls of aluminum or butyl rubber have been used in the United States by Fairchild in their three autoclaves.

As already pointed out, the autoclave tool does not have to withstand the full curing pressure. Because of this, the tools can be very simple and light in weight.

A typical bonding jig has a small degree of curvature in one direction, with the form plate having been rolled to shape from 16 s.w.g. aluminum-rich alloy plate. This form plate is supported on slightly thicker sheets joined together with the aluminum bars to form a supporting frame. Holes are drilled in the form plate for couplings for vacuum lines and also for thermocouples; locating blocks are glued and riveted to the form plate giving positive location for the work.

The work being bonded is then laid on it and held in position with quick release adjustable toggle clamps.

Additional Tooling Required

If a corrugated sheet is being bonded to a flat skin, additional tooling is needed to remove the pressure from the top of the corrugation and apply it to the glue line. This eliminates any possibility of crippling the corrugated section, which is frequently of very thin gauge.

The further tooling needed is a shaped platen which follows the contour of the form plate and to which pressure bars have been attached so that they fit between the corrugations. Alternatively, strips of lead of suitable thickness can often be used and can be bent to shape easily to lie between the corrugations. This bypasses the need for the cover platen between the vacuum bag and the work.

One tool used for bonding a corrugated stiffening to the skins of doors for the Bristol Britannia Aircraft makes use of platens and pressure bars. It simultaneously bonds doubling plates and joggled plates around the window and door lock apertures. For convenience of handling, the pressure platen of this tool is in three separate parts.

An autoclave tool used by Bristol Aircraft Ltd. for bonding corrugated stringers to very thin gauge sheet applies pressure by using light alloy bars which have been machined on one face to receive the stringer. The bars are held in the tool on locating pins so that they are located but can bottom onto the work under pressure. This tool is of interest because it is quite deep.

Loading Trolleys Needed

In a typical bonding installation using an autoclave, loading trolleys are needed to carry the tools and the work into the unit. For convenience, these trolleys are loaded and unloaded away from the autoclave and are brought to it on a cross-traversed trolley from which they can be run directly in or out of the autoclave using a short length of hinged connecting rails.

Whenever possible, a number of jobs are cured at one loading and although the number that can be processed depends on their size, it is usual to have work trolleys fitted with several decks for this purpose.

In this connection it should be noted that the autoclave curing cycle is slightly longer than that of a press. This is because an appreciable amount of time is taken in raising the temperature of the circulating air to the curing temperature and in cooling it once the cure has been completed.

In practice, each part of the component being bonded is pretreated and the adhesive applied to all mating faces. After the elapse of any desired "open assembly" time, the pieces are put together and placed in the tool. At least two thin thermocouple leads are placed as close as possible to the glue line at opposite ends of the work or, alternatively, on the thickest and the thinnest portions of it. If necessary the thermocouples are fixed in position with pressure-sensitive adhesive tape.

Pressure transferring devices such as platens or lead strips are then positioned and the rubber blanket laid over the assembly. A metal clamping frame is next added and fixed in position using an adequate number of quick release toggle clamps before a

test vacuum is applied to make sure that the jig is airtight.

The assembly is then tranferred to the autoclave by the trolleys, the wander leads of the thermocouples are plugged into the appropriate sockets inside the shell, and the flexible vacuum pipe attached to each jig is pushed onto one of the fixed vacuum pipes inside the autoclave. The vacuum can then be switched on for a further check before the door is closed and locked in position by rotating the ring.

High-pressure air is next applied until the pressure inside the autoclave reaches the pressure required for bonding. The steam heating and the circulating fan are then switched on. To achieve as rapid a heating up as possible, the steam pressure used during this period is usually raised considerably above that required to maintain the curing temperature. Once the thermocouples in the air stream have reached the required temperature, the steam pressure is reduced and the regulator set to control the heating automatically during the cure. At the same time, any adjustments to the air pressure are made to compensate for the heating effect on the air. (It has been found that the air in a cold autoclave heats to temperature more rapidly if it is pressurized. This is because of its higher conductivity in this state).

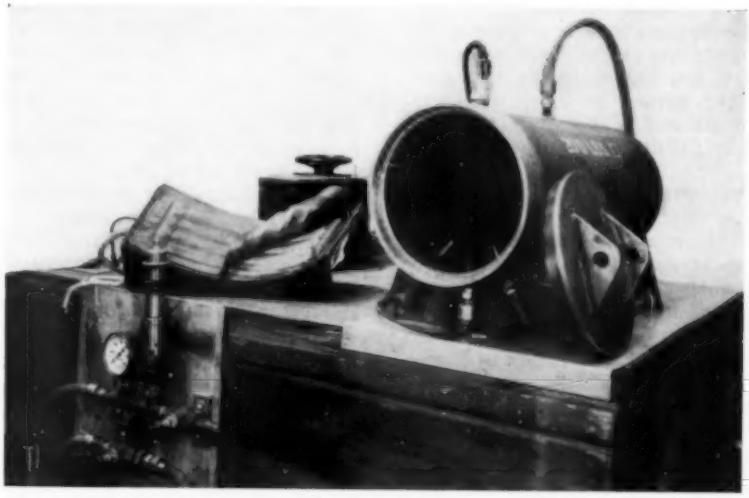
Temperature Check

Once all the glue line thermocouples indicate a temperature within the curing range, the cure is assumed to have begun and is allowed to proceed for the requisite time.

At the end of this period, the steam is shut off and the circulation of cooling water commenced. This cooling is allowed to proceed until all the glue line temperatures have fallen below a predetermined maximum, based on considerations of the thermoplasticity of the adhesive system being used. This stage can often be reached more rapidly by a judicious introduction of cold air, lowering the autoclave pressure slightly and at once increasing it with cold compressed air from the mains.

In normal production, time can also be saved if the autoclave is decompressed at the "safe" temperature so that the cured work can be removed while it is still warm. A fresh load for curing can then be introduced while the autoclave is still considerably above ambient—thus reducing the next heating up time.

Original pressure box tool used by Bristol Aircraft Ltd. It consisted of a steam heated base, a cast zinc alloy female die, a rubber pressure bag and a bolted-on hood. By inflating the rubber bag, 200 pounds per square inch pressure could be applied to parts.



Laboratory scale autoclave built by Bristol Aircraft Ltd. It was made to establish the soundness of the autoclave bonding concept. The basic unit is an eight-inch steam pipe with a screwed-in door. The bonding jig is shown left of the autoclave.

In conclusion, some reference must, of course, be made to the relative merits of autoclaves in contrast to the more conventional presses for bonding metal to itself.

As already mentioned, the tooling for autoclaves is often simpler and lighter in weight than that needed in presses. In view of the low-pressure loading on the jig when using the

Example of a deep autoclave bonding tool used by Bristol Aircraft Ltd. It was used for bonding corrugated stringers to thin sheet by the Redux process. Autoclaves enable more parts to be cured at one time.

autoclave method, aluminum-rich alloys can be used for its construction with obvious advantages in matching the thermal expansion of most aircraft parts, thus simplifying the design and manufacture of the jig. These factors become even more important when parts of complex curvature are being bonded. It is doubtful whether the use of adhesives on such parts would have been economic in the United Kingdom if the press method only had been available.

The next important advantage of an autoclave is the fact that it can handle much larger loads than most presses—yet its cost is seldom higher. In many instances it has been much less and, for example, Fairchild Aircraft Division has stated that a hydraulic press capable of bonding 800 square feet of glue joint per 24-hour day, cost $75,000, whereas an autoclave having an output of 1000 square feet in the same time, costs only $70,000.

Price Plus Maintenance

The cost of maintenance must, of course, be added to any initial price advantage. When the relative number of moving parts, hydraulic systems, and size of steam channels, etc. in each type of equipment is compared, it is quickly appreciated that autoclaves must be cheaper to maintain than presses. Similarly, a wide diversity of shapes to be bonded have been found to cause platen distortion of presses whereas this factor is nonexistent with autoclaves.

On the other hand, it must be agreed that the autoclave curing cycle is usually much longer than that for a press. While this is often offset by the greater number of parts that can be cured at one time, this advantage can only be gained by using a greater number of tools per cure.

The availability of synthetic rubbers which will withstand the curing temperatures employed for the majority of high-strength adhesives has to a large extent offset the disadvantage of the high cost of these vacuum blankets.

These factors should be considered carefully when deciding which type of equipment is best for a particular project. It may be of interest to note that during the past five years there has been a distinct trend in the United Kingdom and the European aircraft industry towards the use of autoclaves in preference to presses for metal bonding processes.

Glass-Ceramic Cements Provide Devitrified Seal

A radically new glass sealing material recently developed has service temperatures close to sealing temperatures.

Named Pyroceram Brand Cement, the glass when fired develops a partially crystalline structure which results in a devitrified seal much stronger and harder than a vitreous seal. This feature means that the seal will not distort even though it is taken repeatedly to the temperature at which it was fired.

The cement's ability to repeatedly withstand sealing temperatures creates two concomitant features. One is that complex pieces can be joined in steps, since successive sealing operations will not deteriorate seals made previously. The other is that defects can be repaired easily and quickly, since the existing seal will not be harmed by firing additional cement over pin holes, vacuum-tight bleeds, stress cracks or the like.

Three designations of the cement have been announced so far by Corning Glass Works. They differ in their thermal coefficients of expansion and, therefore, in their uses. With these cements, materials may be bonded or sealed that have expansions ranging from tungsten in the low range to chrome-iron stainless steel in the high range.

The cements consist of finely powdered glass suspended in low viscosity vehicles. They can be applied by dipping, pressure, flow or brush. The green seal is ready for firing as soon as the vehicle is evaporated. Until firing, the cements are chalky and do not make satisfactory seals. After firing, the seals are strong, vacuum-tight and possess their unique thermal properties.

The material gets its name because the partially crystalline structure that occurs upon firing is analogous to that of the two types of Pyroceram currently available. Pyroceram is a Corning material that begins its history as true glass but is converted into a rugged ceramic-like substance.

The three classes of Pyroceram Brand Cement are designated by the numbers 45, 89 and 95, which indicate the approximate thermal coefficients of each.

Number 45 has a maximum service temperature of 700°C. and an expansion range of 40 to 50 x 10^{-7}/°C. It is compatible with the standard electrical ceramics such as forsterite and steatite, with tungsten and molybdenum, and with glasses equivalent to Codes 1710, 1720 and 1723.

The maximum service temperature of Pyroceram Cement 89 is 425°C. Its expansion range is 80 to 92 x 10^{-7}/°C. It is compatible with forsterite, steatite, alumina ceramets, platinum, vanadium, Dumet, 50 per cent nickel, Driver-Harris alloy #52 and glasses equivalent to Corning Codes 0010, 0120, 0122, 0281, 8870 and 9010.

Number 95 also has a maximum service temperature of 425°C. but has a higher expansion range—90 to 110 x 10^{-7}/°C. It is compatible with forsterite and steatite, also with most lime and electronic glasses including those equivalent to Corning Codes 0080, 0088 and 8871, and with chrome-iron stainless steel, Sylvania #4, 50 per cent nickel alloys, Dumets, thorium and beryllium.

The cements are available in any quantity without the suspension vehicle, or in one- and five-pound kits that include both powdered glass and the vehicle. Before use, containers must be kept closed to avoid a change in suspension characteristics.

Many vehicles are satisfactory for suspending the powdered glass. Even water has been used with success.

A small beaker and a stainless steel spatula are convenient for mixing the suspension. Only enough should be mixed for the job at hand. Generally, the mixture will keep for four to six hours in a closed container. If evaporation should make it too thick, a small amount of amyl acetate can be added. Storage for longer periods,

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Industrial Components Sales Dept.
Technical Products Division
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Corning, New York

however, may result in a rubber-like set that is difficult to break.

The weight ratio between powdered glass and the vehicle will depend upon the type of application and the amount of spreading that is desired. Usually, a ratio of 12 to one is satisfactory. Lower ratios often result in too much spread in the seal area.

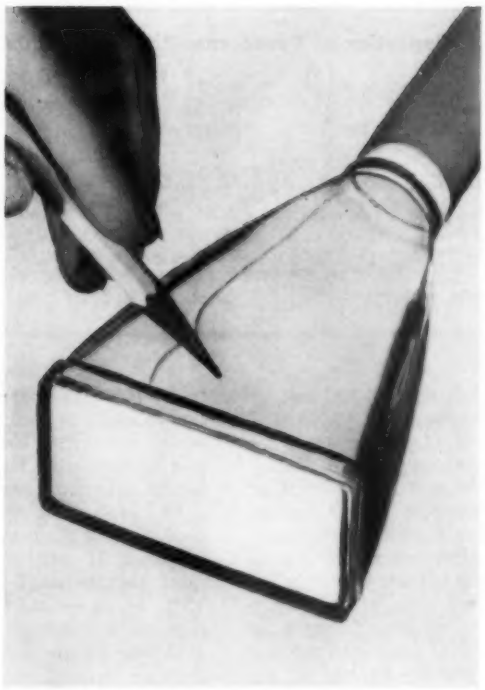
As with any bonding technique, care must be taken in preparing the surfaces to be joined, since grease, oil, fingerprints or any other organic or inorganic material will contribute to seal failure by chemical or mechanical interference. Surfaces of both parts should be scrubbed gently with lint-free paper tissue or cloth that has been soaked with acetone, or similar solvent.

One convenient method of applying the mixture by hand utilizes mouth pressure and a pipette. The pipette can be about six inches long, made of ½-inch glass tubing, and have a bulb 1½-inch in diameter located about ¾-inch from an orifice of ⅛ to 3/16-inch.

The solder glass may also be applied from a plastic squeeze bottle, toothpaste tube, small paint brush or even a spray gun.

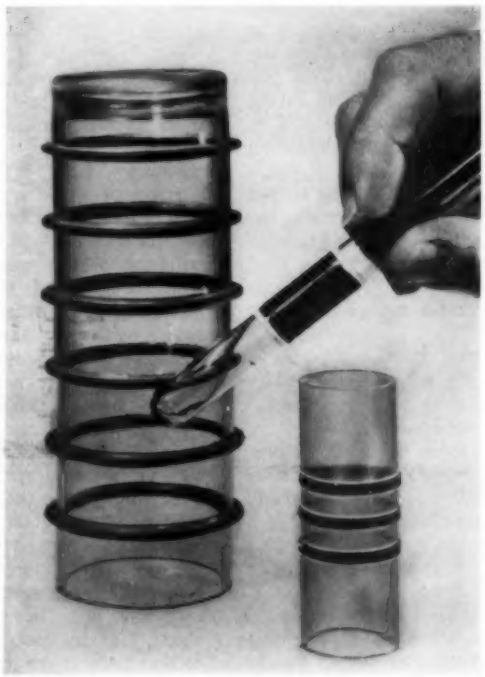
Another technique is dipping. In this case, the suspension should be mixed at a ratio greater than 12 to one to provide less viscosity. Two dips are necessary: the first will produce a thin coating of the suspension; when partially dried, this surface then will pick up a thicker layer during the second dip. The dipping technique is advantageous in that it results in a naturally-formed fillet.

To prevent darkening of the sealing glass during firing, the amyl acetate in the suspension should be dried out of it. This can be done with several hours of air drying in a well-ventilated area; however, oven drying at 115°C. for 15 to 30 minutes is preferable. A bank of heat lamps, arranged to bear on the frit, works very well. The oven used for remov-



A rectangular face plate is frit-sealed to a cathode ray ray bulb with Pyroceram No. 89. The glass-ceramic cement seals glasses, metals and ceramics with thermal expansion coefficiencies between 80 to 92x10^{-7}/°C.

Here the glass-ceramic frit has been used in stack mount type tube construction. It has a sealing temperature of 750°C. and can be used in service continuously at 650°C. The illustration is of glass-to-molybdenum seals.



Properties of Pyroceram Brand Cements

	No. 45	*Nos. 89 and 95*
Young's Modulus	9,000,000 psi	6,600,000 psi
Modulus of Rupture 25°C.	10,000 psi	6000 psi
Density	3.3	6.5
Thermal Expansion, $\times 10^{-7}$/°C.	42	80 to 110
Seals at	750°C.	440°C.
Continuous Service Temperature	650°C.	400°C.
Log DC Resistivity at 250°C.	13.7	8.5
at 350°C.	11.6	7.0
Dielectric Constant at 25°C.	6.1 at 1 kc	21 at 1 kc
Loss Tangent at 25°C.	below .002 at 1 kc	.001 at 1 kc

ing the amyl acetate should not be used for firing the seal.

One or both of the bodies to be sealed must be pre-glazed if sealing is to be performed in a neutral or reducing atmosphere. In pre-glazing, the solder glass is sufficiently heated to make it glassy—forming a continuous surface but not yet devitrifying. Pre-glazing time for all three cements is ten minutes; temperature required is 660°C. for the 45 cement, and 390°C. for the 89 and 95 cements.

If the solder glass is suspended in nitrocellulose amyl acetate, the pre-glazing must be performed in an oxidizing atmosphere. When pre-glazing a readily oxidizable metal, the frit must be suspended in pure amyl acetate and firing performed in a vacuum at no more than 660°C.

As might be expected, the expansion coefficient of the glassy, vitreous material is quite different from that of the final devitrified material. It is the latter expansion that is the basis for selecting one cement over another. Therefore, it is possible during pre-glazing—when the seal is still in the vitreous state—for an expansion mismatch to create cracks.

If the cracks are confined to the solder glass, there is no concern, for they will fire out during sealing with no ill effects. However, a slower heat rate during final sealing may be necessary to prevent breakage from heat shock.

Sintering may be the solution in this case. This is a partial pre-glazing that can be done at a lower temperature. In subsequent operations, though, care must be taken to prevent contamination of the porous material that forms during sintering.

The sequence of events during a sealing operation are as follows:

The solder glass melts, maintaining low viscosity long enough to allow excess glass to flow out of the interface and form a fillet. During this stage, the substrate is wetted by the solder glass, and the mutual interaction results in a good bond. Then the solder glass devitrifies, and the result is a mixture of crystals and a glass harder than the original solder glass.

In cases where the green frit is fired directly the heating rate can be whatever the item being sealed can take. Representative rates are 10° or 15°C./minute until the sealing temperature is reached. Rates less than 2°C./minute are not recommended, because devitrification might begin before a good seal is obtained.

Cement 45 should be sealed at 750°C. for one hour, with heating and cooling rates of three to five degrees Centigrade. In special cases, trial might show better results with somewhat lower or higher temperatures and/or slower heating and cooling.

The normally recommended schedule for the 89 and 95 cements is 440°C. for 60 minutes. Other rates are 90 to 120 minutes at 425°C. or about 30 minutes at 455°C.

All these schedules are merely guides. To get best results in each case, experimentation must be carried out. This is because there is a variety of cements, a very wide variety of substrates, as well as differences in seal geometries—all contributing to heat transfer that is correspondingly varied.

In cases where the sealed item must undergo further thermal processing—exhaust bakeout, for example—the best schedule again should be determined experimentally. Excessive temperature should be used with caution because it is possible to over-devitrify the sealing frit.

It is very important that all parts of a joint be at the same temperature when the glass devitrifies. Absolute knowledge of the joint temperature, not merely the furnace temperature is essential. Where temperatures have been recommended, they refer in each case to actual temperature at the joint.

Acid-resistant stainless steel, glass and ceramic parts can be salvaged after sealing by immersing them in ten per cent nitric acid at 50° to 60°C. For certain seal shapes, faster salvage can be accomplished by first immersing the seal in the nitric acid bath to dissolve the fillet, then subjecting the seal to thermal shock from an outside heat source.

Application equipment can be readily cleaned of nitrocellulose residue by rinsing it several times with acetone. The remaining glass frit can be flushed away with water, rinsed with acetone and dried. The sealing glass adhering to the inside of glass pipettes can then be dissolved with ten per cent nitric acid.

The suspension vehicle is flammable and extremely volatile. It should be kept and used in adequate ventilation and away from open flames. Acetone also requires caution because of its flammability and the toxic effect of its fumes.

The Pyroceram cements contain a high percentage of lead oxide, so the following rules should be followed to lessen the chance of lead poisoning:

(1) Wear a respirator while handling the powdered glass.

(2) Wash hands thoroughly, especially under the nails, after working with either powder or paste. Never eat, drink or smoke without washing.

(3) Wear a lab coat, and leave it at the work location.

The Pyroceram cements were especially designed for use in sealing operations as covered by U. S. Patent No. 2,889,952. However, purchase of Pyroceram cement does not carry with it an express or implied license under this patent. Licenses are granted by Corning Glass Works at reasonable royalty rates.

The cements are not recommended for applications involving prolonged immersion in nitric acid, sodium hydroxide or boiling water.

About the Author . . .

HAROLD L. PUTNAM began his career with Corning as a process engineer in the company's Vycor Plant shortly after graduation from the University of Virginia with a Ch. Eng. degree in 1949.

Airless Spraying of Douglas DC-8 Jet Bonded Subassemblies

An airless spraying technique suggested by a maintenance department application recently helped Douglas Aircraft Co., Long Beach, Calif., break a bottleneck on production line bonding of subassemblies.

Though Douglas' Long Beach Division has been bonding subassemblies for years, until recently the adhesive was merely hand-brushed onto parts in an air conditioned, humidity controlled room. However, with the speedup brought about by the DC-8 jet liner program, the need for bonded subassemblies increased so rapidly that the cumbersome hand-brushing technique was inadequate to the workload.

Worried production engineers decided to test various adhesive application methods. A roller technique tried also proved unable to handle the increased volume. An air spray gun tested did a reasonably good job, but the turbulence created by the 600 parts of air needed to atomize one part of adhesive tended to carry the bondant away from the "target." In addition, because the surrounding area quickly became impregnated with highly volatile adhesive fumes, it was apparent that conventional air spraying would require installation of a vented spray booth to take care of overspray.

Preliminary investigation showed that such a booth would cost more than $20,000—exclusive of maintenance costs. Another fairly important factor would be the annual cost of additional makeup air in the air conditioned, humidity controlled room.

At this point, the idea of using an airless spray gun was considered. Since this type of equipment was already in use by the plant maintenance department for spray painting, it was known that both overspray and bounce back were kept at a minimum because there was no stream of air to mix it with the surrounding atmosphere.

In the equipment being used, a Nordson Airless Spray System, the paint was atomized by the injection of hydraulic pressure. Forced through a small orifice, the paint atomized as soon as it struck the air.

It was decided to give the maintenance department's spray equipment a tryout. Mounted on a dolly, the pump and heater unit was set up just outside the metal bonding room. The spray gun was connected to the system by means of metal-encased, high-pressure hoses running through the wall of the room.

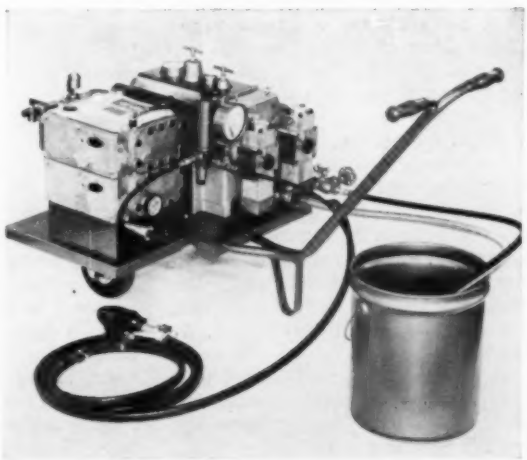
The adhesive supply was kept in a five-gallon can inside the bonding room. It was pulled into the system as needed by a siphon action of the unit.

The Nordson Airless System is activated by an air-operated motor which drives a two-cylinder, constant-pressure, variable-delivery pump. This pump is connected into a continuous circuit with a heating unit and spray gun, and continuous circulation is maintained. This provides even temperature of the coating material, eliminates variations due to climatic changes and prevents adhesive from solidifying if the spray gun is not triggered for some time.

Douglas ran a number of tests to establish the optimum spraying pressures and temperatures to use with the adhesive employed. As a result, the spray application is carried out at 600 psi and 100°F.

Parts being prepared for bonding are sprayed on an open bench in a controlled room environment of 72°F. and 40 per cent humidity. The airless spray technique causes no more air contamination than the previously used hand-brushing method. Air fouling caused by the normally high volatility of the adhesive is effectively controlled by the room's air conditioning system.

All hoses leading to the unit are the quick-disconnect variety, so that the unit can still be used by the maintenance department when not needed in the bonding room.



A Nordson Hot Airless Spray System similar to the one used at Douglas' Long Beach plant. It replaced a cumbersome hand-brushing technique previously used in spreading subassemblies.

How to Use Compressed Air in Wood Bonding Operations

One highly-interesting use of compressed air in bonding operations is the incorporation of a pneumatic cylinder, in connection with a microswitch, for automatically positioning the top roll of a glue spreader. In jobs where it is essential to have a double glue line between layers, this modification will provide two different predetermined openings between the roles.

Three-ply materials can be made with a single glue line between layers by running the center ply through a double-coating spreader. However, when bonding materials, such as building board, insulating board, etc., have high absorption qualities in addition to a considerable amount of surface irregularity, it is highly desirable to use a double glue line between layers.

In these operations, the center sheet is first run through a double-coater. Then the two outer sheets are run through the double coater face to face so that only one side of each is coated. However, when the two face-to-face sheets are run through together, the rolls of the machine must obviously be reset.

This process has been greatly simplified by Black Brothers Company through employment of the pneumatic automatic roll-positioning device mentioned. The pneumatic cylinder is actuated by fingers which contact the material only when the stock is of sufficient height to require raising the upper roll. When a single center sheet is fed to the machine, the contact fingers do not touch the stock.

When the contact fingers actuate the microswitch, it in turn actuates a pneumatic relay controlling pneumatic valves which operate the air cylinder. The valves employed are adjustable for any machine speed, any length of material, etc. The pneumatic cylinder can raise the top roll a maximum of two inches, if necessary.

A unique compressed-air application is employment of a series of oversize hose lengths for actuating the top platen of a laminating press, and applying necessary pressure. This method is used chiefly on work laminated with bondants requiring only moderate pressure such as the vinyls and protein latex types. Where this moderate pressure is sufficient, however, the process can reduce costs greatly.

The basic press is made of structural steel, with a stationary lower bed, made up of I-beams. The upper platen is movable and is suspended from the press crown with the series of closely-spaced oversize hose members sandwiched in between.

By suspending the top platen on rods, and mounting compression springs on the rods, the springs function to hold the top platen against the under side of the press crown in such manner as to keep the series of oversize hose lengths collapsed when there is no air in them.

Applying Pressure

After a load is placed in the press, pressure is applied by simply valving compressed air into the several hose lengths at the same time. The expanded hose lengths drive the top platen downward onto the work.

Approximately a four-inch stroke can be obtained by expanding the hose lengths fully, however, a two-inch stroke is generally more efficient. It will deliver a pressure of about 60 psi over the entire platen area, if it is assumed that shop air pressure is 100 psi. Where area of the load placed in the press is smaller than that of the entire platen, proportionately higher pressure is obtained.

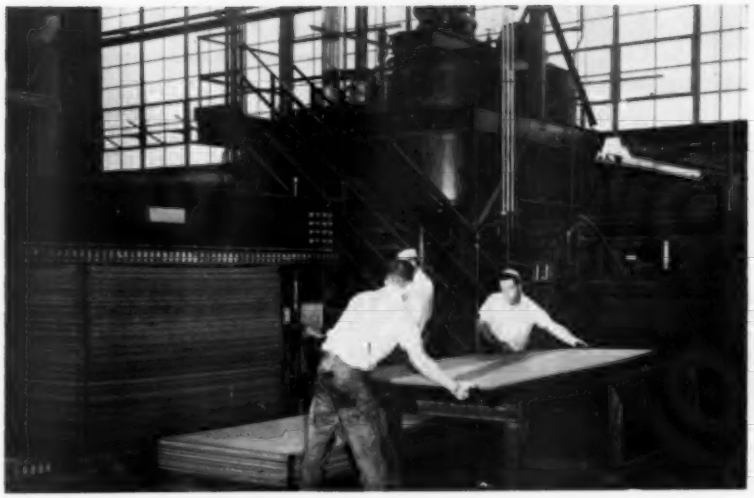
The air valve is located at one corner of the press, at convenient working height. When it is used to admit air, expansion of the hose drives the top platen against the gang of compression springs upon which it is suspended. When pressure is subsequently released, the compression springs automatically react, lifting the top platen back to its normal top position, with the hose lengths collapsed again. Such presses have become highly popular in fabricating hollow-core flush doors, plastic-faced plywood, panel-on-frame work, etc.

Increasing numbers of rotary presses such as those made by Black Brothers are being used to combine various types of dissimilar plies, often in connection with contact adhesives. Most of these presses are built with two husky air cylinders, positioned on top with their axes verticle at the sides of the machine so as to apply downward pressure to the top combining roll of the machine.

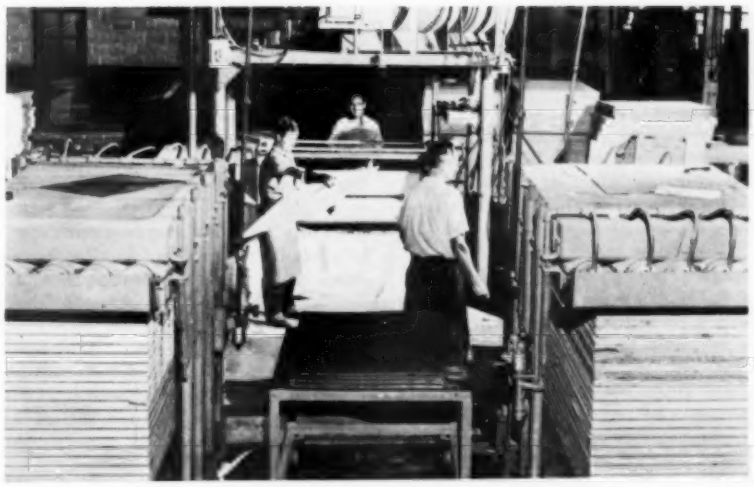
Often, components are preliminarily spread with glue and processed through an oven of one type or another, to hasten the reduction of the spread adhesive to a proper tacky condition. The components are then placed together and run through the rotary press. Infrared ovens (or banks of infrared lights) are often used for this purpose. The drive for the rotary press incorporates a variable-speed device to allow selection of the pressing speed best suited to plant conditions in various geographical locations.

Various other aspects of compressed-air application might be cited. For example, the same general type of rotary press may be fitted with a pneumatic relief device for the opening between rolls. Such presses are often employed for applying laminated plastic to large L-shaped or U-shaped plywood assemblies used in manufacturing special kitchen cabinet tops or continuous counter tops.

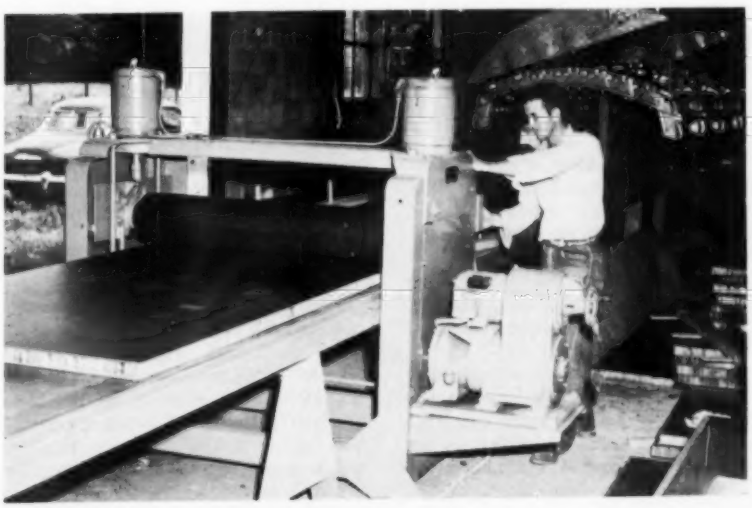
In combining laminated plastic with the base plywood on such assemblies, it is important to have the pressing action continuous from one end of the L or U to the other. To do this, it becomes necessary to shift the workpiece, or pivot it between the rolls, when one reaches a corner of the L or the U, respectively. The pneumatic relief referred to provides just enough pressure release or roll opening at these points to allow such shifting. It also provides for immediate reapplication of pressure and resumption of forward feed.



This gluing layout is used in bonding sheets of building board. The large glue mixer and tank in the rear is elevated so that adhesive can be valved to the spreader by gravity. The spreader, right, is equipped for pneumatic top-roll positioning. Spread material is received on the outfeed table and laid together three-ply on a rollway at its left to build a package.



The glue spreader seen here in the center background is flanked by two Black Brothers air-hose presses. To conserve floor space, the air compressor is located directly above the spreader. When a package has been laid up, the air-hose press under pressure longest is unloaded and a new load is run in. During this operation, a new load is built up behind the spreader.



Looking at the outfeed side of a modern rotary press of the pneumatic type. The two air cylinders which apply pressure to the top combining roll can be seen on both sides of the press, at top. Note the infrared oven in the background. (All photos on this page are courtesy of Black Brothers Co., Inc., Mendota, Illinois.)

The Development of Foamed Phenol-Formaldehyde Resin for Plywood Gluing

By HARLAN G. FREEMAN and BROR SORSA

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While foamed resin adhesives have been a subject for discussion and research for two decades, the past few years have seen a resurgence of special interest.

Writing in 1958, Bornstein (2) reported that the principal advantage of foam extension is lower cost resulting from the cheapness of air as an extender, reduced inventory problems with no extenders, and lower labor costs because of the lower spreads and consequent less mixing of glue. Additional advantages cited by Bornstein are better water control in plywood resulting in improved dimensional stability and less abrasion in subsequent machining because of thinner glue lines. Ziegler (*10*) states that the mechanical foams developed by A. D. Little, Inc. offer better coverage, easier spread control, less wastage, and superior bonding of porous materials at the same or at a reduced cost.

Writing in a more specific manner, Mori (*6*) reports that the foamed urea-resin glued plywood had similar durability to that of the common extended urea-resin plywood. Plotnikova (7) studied the properties of foamed urea-resin in relation to foaming agents, pH, and the rate of foaming.

In Finland, a project investigating urea-formaldehyde resin foaming was initiated at the State Technical Reasearch Institute. The results, as set forth by Lähteenmäki (*4*), indicated that suitable foaming agents for the urea-resin were saponin, dried blood, casein, and hydrolyzed protein that has been condensed with fatty acid chlorides. Lähteenmäki reported that a successful foaming system was produced by mixing the foaming agent with the resin, hardener, and starch, and then beating. After the mixture had reached the required density a small amount of commercial anti-foam was added and the foamed resin applied to the spreader. With proper proportions of the various components, stable foams could be produced.

Supplementary investigation showed that casein was the best foaming agent with reference to stability of the foams upon standing. Also, it was discovered that certain amounts of wheat flour would inhibit foaming on the spreader, thus obviating the use of the anti-foaming agent. These later urea-resin foams contained resin, hardener, starch, water, casein and wheat flour. Thus the basis for development of a satisfactory phenol-formaldehyde resin foam system was laid.

Certain standards were established by which to judge the phenol-formaldehyde resin foams as to their commercial suitability. It was decided that small mixtures of from 500 to 1000 grams should have a stability on the spreader of at least one-half hour. Because the spreader was equipped with rollers containing small grooves (20 per inch) the required foam specific gravity was about 0.70. With small grooves it is difficult to spread a sufficient quantity of glue when foams of lower specific gravity are used.

A further requirement was that there would be no drainage or separation of the prepared foam after two hours of standing. Finally, all foams produced with the satisfactory characteristics would have to prove adequate in the gluing of plywood.

For the foaming trials a small mixer (Figure 1) was used. It was equipped with a combined pulley and variable speed motor drive. Mixing speeds as low as 200 revolutions per minute were possible and the upper limit was beyond practicality. A Black Brothers 26-inch spreader, equipped with a variable speed motor capable of speeds of from 20 to 130 feet per minute, was employed in the foaming and gluing trials. The doctor rolls on the spreader were not used, the glue being spread in the customary Finnish manner with the distance between the large spreader rolls determining the quantity of glue spread. The lower roller carried the glue from the trough to the upper roller, and a "sausage" of glue was formed between the lower and upper roller on the infeed side.

Volumetric containers and a balance were used to measure foam specific gravities.

In the laboratory, experimental plywood panels were pressed on a Fjellman 24 x 36-inch hot press. The plywood was evaluated with the

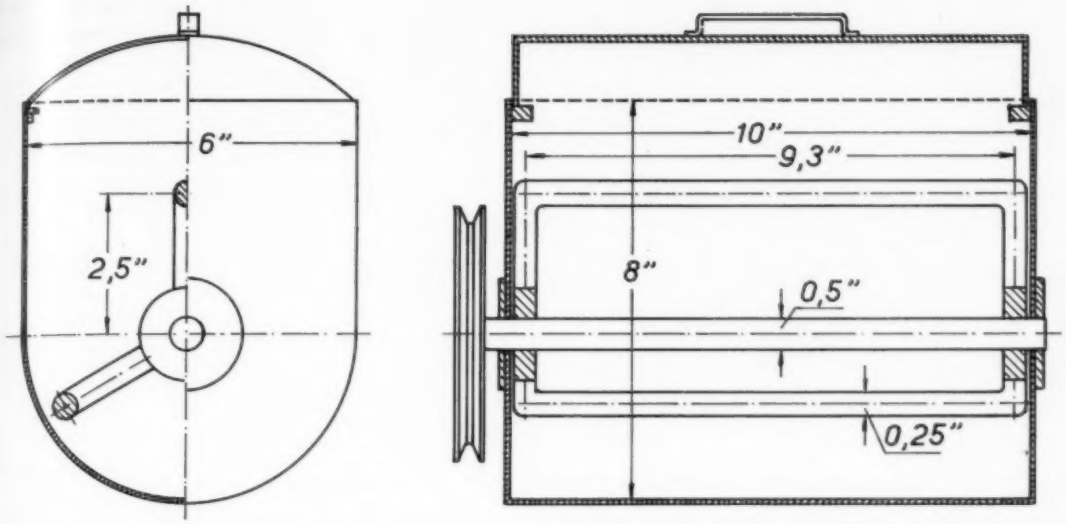

Fig. 1—Mixer used to produce resin foams in the laboratory. Equipped with a combined pulley and a variable speed motor drive, the mixer was capable of speeds as low as 200 revolutions per minute. Foaming glue trials employed a Black Brothers 26-inch spreader unit.

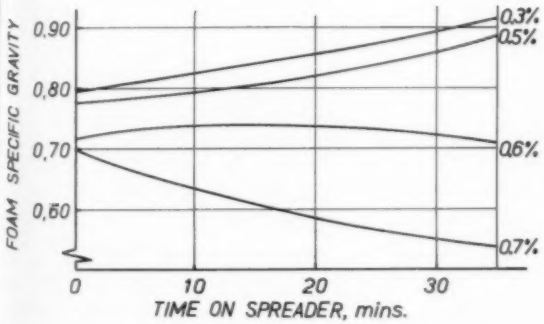

Fig. 2—Specific gravity vs time for foams prepared with 500 grams of Exter "A," 1.5% bentonite, 30% water, 2% quebracho, 3% paraformaldehyde, 1% starch and indicated amounts of dried blood.

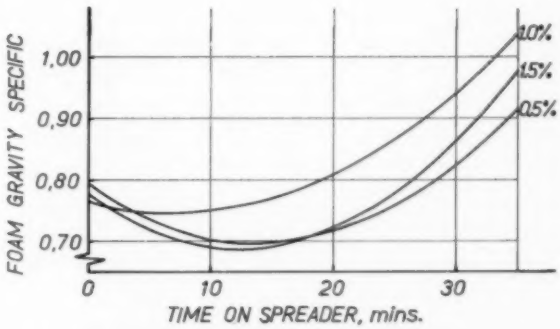

Fig. 3—Specific gravity vs time for foams prepared with 500 grams of Exter "A," 1.5% bentonite, 25% water, 2% quebracho, 3% paraformaldehyde, 0.6% dried blood and indicated amounts of starch.

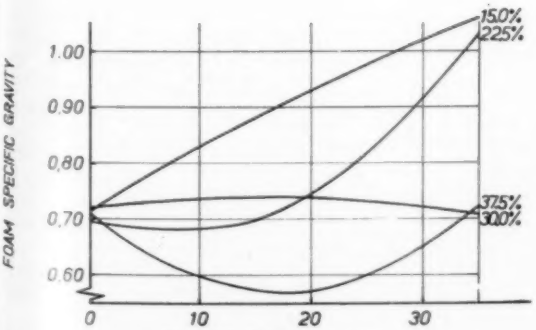

Fig. 4—Specific gravity vs time for foams prepared with 500 grams of Exter "A," 1.5% bentonite, 2% quebracho, 3% paraformaldehyde, 1% starch, 0.6% dried blood and indicated amounts of water.

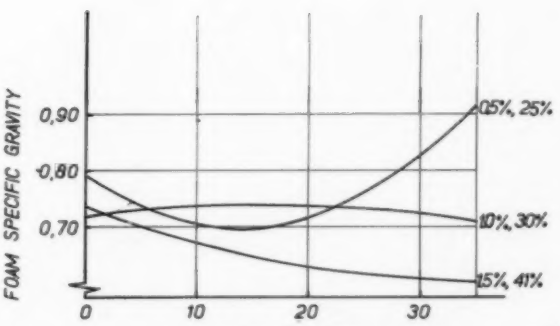

Fig. 5—Specific gravity vs time for foams from 500 grams of Exter "A," 1.5% bentonite, 2% quebracho, 3% paraformaldehyde, 0.6% dried blood, starch (small number) and water to give 98 cp at 20°C.

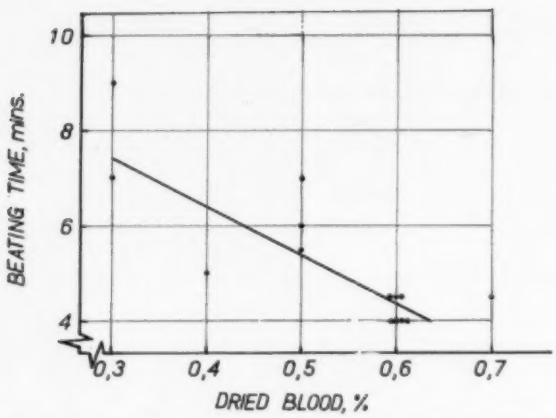

Fig. 6—Beating time to produce a foam with specific gravity of 0.70 to 0.79 vs percentage of dried blood. Figures 2 to 7 show results of foaming tests in which initial viscosity is minimized.

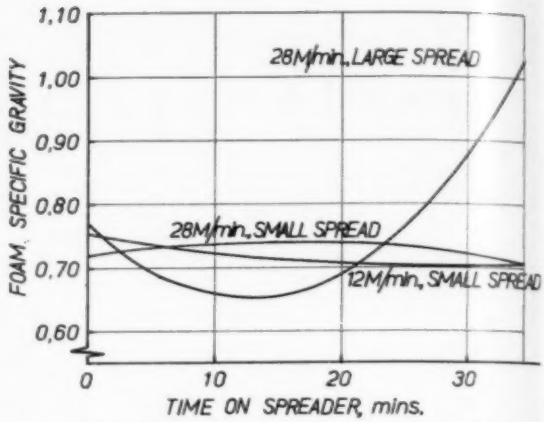

Fig. 7—Specific gravity vs time for foams of 500 grams Exter "A," 1.5% bentonite, 30% water, 2% quebracho, 3% paraformaldehyde, 1% starch and 0.6% dried blood. Note three speeds.

knife test and final shear testing done on a Hounsfield Tensiometer.

In most tests 500 grams of Exter "A" resin were used and the components added as percentages of resin weight. Exter "A" is a 42 per cent solids, phenol-formaldehyde resin manufactured by Malla, Oy. of Tampere, Finland. Some tests were also conducted with Bakelite resin, G 17432 and Charles Lowe resin, AC 490A, both about 45 per cent solids and manufactured in England.

The foaming properties of all the resins were similar—taking into account the differences in viscosity. The basic foams contained resin, 0.5 to 2.0 per cent starch, one to two per cent bentonite (Wyoming, sodium treated), 20 to 40 per cent water, 0.1 to one per cent dried blood and a hardener consisting of varying amounts of quebracho and paraformaldehyde.

The additives were grouped so that one mixture contained the blood, starch and part of the water, while the other mixture contained the bentonite, quebracho, paraformaldehyde and the remainder of the water. The blood mixture was added to the resin shortly before beating in order to minimize the reaction between the blood and the free formaldehyde.

The mixtures were beat in the mixer until foams of the desired specific gravity were produced after which they were transferred to the spreader and the specific gravity observed at 5, 15, 25, and 35 minutes of spreading. The points formed by the foam specific gravity at these times were fitted with a second degree equation by the method of least squares. The quadratic fit was used because, in most cases, the specific gravity versus time relationship was obviously not linear while the relationship generally had only one inflection point. The second-degree curves accounted for 56 to 81 per cent of the variance in specific gravity with the average being 72 per cent.

In evaluation of the foamed adhesive for plywood a number of assembly times were usually used along with two veneer moisture contents, 2.5 and 6.5 per cent. In this way, knife-test comparisons between moisture contents and assembly times could be made and the joints could be compared for evidence of excessive penetration or drying. In addition the two veneer moisture contents were useful in evaluating the susceptibility of the foamed resin system to variation in veneer moisture content.

Minute in Hot Press

Veneer thickness was approximately .055 inch and the glue spread (30 per cent resin solids) about 23.6 pounds per thousand square feet of glue line. Following the particular closed assembly time, the three-ply panels were allowed to stand for one minute in the hot press opening before pressing two panels per opening at 257°F. and 225 psi per square centimeter for six minutes.

Mill-scale testing of the foamed resin was done at the Säynätsalo plant of Enso-Gutzeit, Oy. In general, it was attempted to fit the foamed resin system into the existing production arrangement. Foaming was done in the Arminius-type beaters, manufactured by Manko, Oy., that are presently employed for urea-resin.

Following foaming, spreading was performed by a Raute, Oy., spreader with metal rolls having 12.5 grooves per inch and a feed speed of 98 feet per minute. Evaluation of the plywood produced on the Hydraulik, GmbH., 20-opening hot-press was done initially with a knife-test and shear testing performed in the laboratory later. In two trials at Saynatsalo, the following production schedules were used:

Trial I—spread, 20.5-23.6 lbs./1000 square feet; closed assembly time, 20-25 minutes; press loading and closing time, two to three minutes; pressure at 257°F. for eight minutes, 242 psi.

Trial II—spread, 25. 6-27.6 lbs. 1000 square feet; closed assembly time, zero to ten minutes; press loading and closing time, 2.5 minutes; pressure at 257° for eight minutes, 250 psi.

Exploratory foaming tests indicated that saponin, casein and dried blood were suitable as foaming agents for the phenol-formaldehyde resin. Subsequent testing was limited to the dried blood because of its low cost and the ease with which it could be added to mixtures. In these same early tests, it was found that the addition of starch improved the stability of the foams on the spreader. Other foam stabilizers (5), such as sodium alginate and carboxy-methyl-

cellulose were investigated briefly, but starch was used in all of the later tests because of cost advantages and no apparent relative disadvantages.

The results of early foaming tests using resin, starch, water, and dried blood were poor. Generally, the mixtures, as prepared in the beater, first decreased and then increased in specific gravity on the spreader. This lack of stability could only be eliminated by minimizing the initial viscosity of the resin mixture. Consequently, relatively large amounts of water are used in the phenol-formaldehyde resin foams reported on.

A difficulty with the low viscosity foams was that they drained badly upon standing. It was thought that a substance showing thixotropy in aqueous solution would solve this problem. The addition of one to two per cent bentonite eliminated foam drainage with the mixtures used in these tests. The results of foaming tests in which initial viscosity is minimized and foam drainage prevented by bentonite are shown in Figures 2 through 7. Figures 2 through 5 show the effect of varying the amounts of the additives, blood, starch and water, while Figure 7 indicates the effect of two of the mechanical spreading variables.

The shear strength and percentage wood failure results for plywood manufactured in the laboratory using Exter "A", 30 per cent water, two per cent bentonite, 0.5 per cent starch, 1.5 per cent paraformaldehyde, three per cent quebracho and 0.4 per cent dried blood are shown in Figures 8 and 9, respectively. The samples were tested according to the procedures of the U.S. Commercial Standard for Hardwood Plywood (*3*) using the cyclic boil test.

Results of shear tests for plywood manufactured in the mill in Trial II are shown later. Testing followed the cyclic boil procedure of the Hardwood Standard.

The results of Figure 2 are quite straight-forward, larger amounts of dried blood resulting in foaming on the spreader and smaller amounts resulting in a decrease in foaming. It should be noted that the mixtures are very sensitive to small variations in the amount of the foaming agent.

It can be seen from Figure 3 that small changes in the quantity of starch have little effect upon stability of these mixtures. The result of varying the amount of starch from 0.5 to 1.5 per cent was not enough to alter the specific gravity versus time relationship to any great extent.

Minimize Initial Viscosity

As stated earlier, successful foams from the standpoint of their behavior on the spreader were achieved by minimizing the initial viscosity of the resin mixture. Thus it can be seen in Figure 4 that the effect of water upon stability is quite pronounced. It is thought that the effect of the water content is manifested only through viscosity.

Early in the foaming trials it was noted that un-hardened phenol-resin foams increased in viscosity on the spreader. The reason for this viscosity increase was thought to be poly-condensation resulting from oxidation by the atmosphere. Sodhi (*9*) has indicated that surface oxidation may have a measurable effect upon the viscosity of phenol-formaldehyde resins. Smith and co-workers (*8*) studied the action of inorganic oxidizing agents in reference to acceleration of phenol-formaldehyde resins for plywood gluing.

It has been shown that the rate of increase of viscosity of phenol-resin is great when the inorganic oxidizing agents alone are used as hardeners. A contributing influence may be the acceleration of exchange of oxygen between the liquid and gas phase when the liquid-gas interface is large as in a foam (*1*). Thus it seems reasonable to conjecture that the water content of phenol-formaldehyde resin foams influences the rate of oxidation-induced viscosity increase resulting from the mechanical action of the glue spreader and the corresponding mixing with the surrounding atmosphere.

In order to isolate the effect of changing the water and starch content but not the initial viscosity, the tests of Figure 5 were conducted. Starch was added at three levels and then the viscosities of the mixtures were adjusted to the same value using water, before foaming and spreading in the normal manner.

The results of Figure 5 make it appear that changes in the amount of starch, in the amount of water, or in the amount of both, affect stability even with a constant initial viscosity. If it is assumed that the results of Figure 3 eliminate small changes in starch content as affecting stability greatly, then the dominant factor influencing stability on the spreader is the water content of the resin.

The relationship between the amount of foaming agent (dried blood) and the beating time to produce a foam with a given specific gravity is shown in Figure 6. As might be expected, increasing amounts of blood result in shorter beating times. The beating time versus blood content relationship accounted for 68 per cent of the variance in beating time, being significant at the one per cent level of

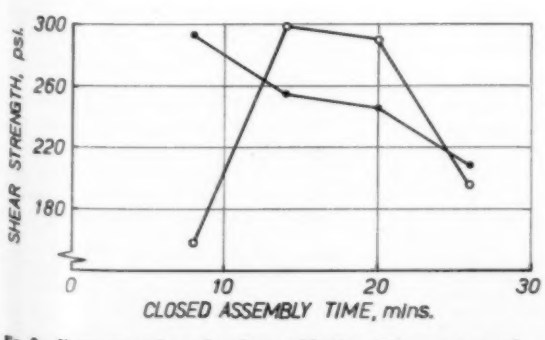

Fig. 8—Shear strength vs closed assembly time at two veneer moisture contents for plywood made with foamed resin. Open data points indicate wet veneer, closed points indicate dry veneer.

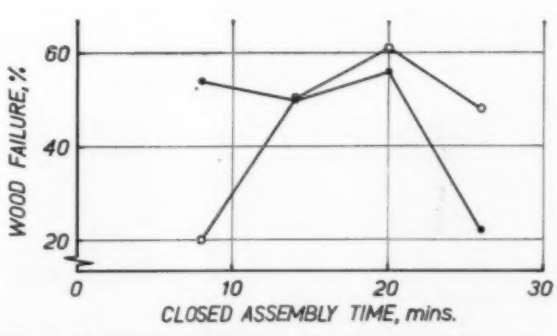

Fig. 9—Percentage wood failure vs closed assembly time at two veneer moisture contents for plywood made with foamed resin. Open data points indicate wet veneer, closed points dry veneer.

probability. The effect of the mechanical foaming factors is shown in Figure 7. Although Lähteenmäki (*4*) reported increased foaming at higher spreader speeds, these results show no such relationship. The higher viscosity of the urea-resin in the previous study would account for differences in results.

With the foams studied here, the amount of resin being spread (carried around the spreader rolls) was related to foaming stability. As shown in Figure 7, an increase in the amount of resin being spread resulted in an initial increase in foaming and a shorter usable life on the spreader. This behavior might be expected since there is a greater mixing or beating action with increased resin spread. Greater beating results in more foaming which leads to lower specific gravity foams and greater oxidation, both of which contribute to higher viscosity of the foam (*1*). When the viscosity of a foam becomes too great, mechanical action causes it to collapse.

The results of the laboratory testing shown in Figures 8 and 9 were quite good considering the low spread of 23.5 lbs. per thousand square feet. With the dry veneer, the first three assembly times were acceptable according to the Hardwood Plywood Standard, while only the two intermediate assembly times were acceptable with the wet veneer. The substandard results were caused by excessive penetration of resin at the short assembly time and by drying at the long assembly time. Even so, the results were thought to be good enough to merit trial at the plywood mill.

Trial I at the plywood mill was conducted using foamed glue mixtures very similar to those used to obtain the test results in Figures 8 and 9. The panels produced were poor according to the knife test performed after pressing. The most general defect was excessive penetration but there was also evidence of drying or pre-cure. Because the knife-test results were so poor, no shear testing was conducted. It was noted that the variation in veneer moisture content was greater than expected and there was also the possibility of variation in spread within one veneer sheet. Upon return to the laboratory it was thought that an ideal development would be to formulate a foamed resin that would not penetrate the wet veneers at assembly times as short as one minute.

Examination of plywood manufactured with veneers at 10 per cent moisture content revealed that there was difficulty in getting satisfactory knife-test results even when assembly times were as long as 30 minutes. The fresh, low-viscosity 75 cp at 68°F. Exter "A" resin was so thin that penetration could not be avoided with these wet veneers.

Corresponding tests to determine drying characteristics of the foamed resin system with dry veneer showed more promise. Satisfactory knife-test results were produced with oven-dry veneers at assembly times as long as 37 minutes when using a glue-spread of 23.6 lbs. per thousand square feet. Since, at these long assembly times satisfactory bonds were also produced with the wet veneers, further development was along this line. The amount of quebracho in the mixtures was maximized and the viscosity kept as high as possible. In this respect, attention was concentrated on the Charles Lowe resin AC 490A, because of its viscosity of 450 cp at 68°F.

In the spreading of these high-viscosity foams it was observed that stability on the spreader was shortened somewhat. Even so, it was felt that the usable life on the spreader was adequate. A second problem was that in minimizing the amount of dried blood in order to regulate foaming and stability on the spreader, the initial beating time in the mixer became somewhat extended. This problem was solved by increasing the amount of dried blood so that beating time was short and then adding a commercial anti-foam to regulate the foam specific gravity on the spreader.

A suitable mixture was 500 grams of Charles Lowe resin AC 490A, two per cent bentonite, 0.5 per cent starch, 30 per cent water, seven per cent quebracho, 0.5 per cent paraformaldehyde and one per cent dried blood. Beating of this mixture to the desired specific gravity was followed by addition of 0.1 per cent anti-foam, Valke F, manufactured by Valke, Oy. After very brief mixing, the foam was applied to the spreader and behaved satisfactorily. In the plywood gluing with wet veneers, knife-test results were improved while the permissible assembly time with dry veneers was still very much too long.

Plywood Mill Trial

Since the higher-viscosity mixture showed promise in the laboratory, Trial II was conducted at the plywood mill. The gluing mixture was the same as that just described and foaming and spreading characteristics were seen to be excellent. In the mill it was observed that the veneer was of low two to six per cent moisture content. Plywood was produced using the production schedule described earlier and knife-test results were excellent.

For the two press loads involved, test samples were cut from the plywood of the upper and lower press openings, insuring the full range of assembly times used, and tested, both dry and following the cyclic boiling. The percentage wood failure and shear strength results for the dry shear test were 93 per cent and 429 psi. For the cyclic boil test the figures were 86 per cent and 370 psi. These results indicate that the foamed resin is capable of producing high-quality, waterproof plywood efficiently.

While gluing costs for plywood of this sort vary widely from mill to mill, it is of interest to note that the gluing costs for the mixture of Trial II are about $9.58 per thousand square feet of ¼-inch plywood. Of this amount over $8.60 is resin cost and over $0.57 is hardener cost. Even though this $9.58 figure does not include the ten to 20 per cent

About the Authors . . .

H. G. FREEMAN is working on plywood adhesives for Weyerhaeuser Co. The work described in this article was completed while he was studying at the Finland Institute of Technology on a Fullbright scholarship.

B. SORSA is a research engineer in charge of wood gluing at the State Institute for Technical Research (Finland). He is also a consultant to the Finnish wood industry in both a national and international capacity.

waste value that is customarily used in calculating plywood manufacturing costs in Finland, it is still low enough to be of interest to producers. Undoubtedly, the glue spread and cost can be further minimized, but it is not known to what extent manufacturers will decrease their margin of safety on the Type I, waterproof bonds.

The results of the foaming tests indicate that phenol-formaldehyde resin foams of adequate stability can be produced with the relatively common additives, starch, dried blood, bentonite and water. It is postulated that lack of stability of phenol-resin foams can be primarily attributed to oxidation and that it is through retardation of the oxidation-induced viscosity increase that the higher water contents are manifested.

For hardening, various amounts of quebracho and paraformaldehyde can be used, however improved plywood bonds were obtained when the amount of quebracho was high.

Using high amounts of quebracho and a commercial phenol-formaldehyde resin, plywood of the Type I, fully waterproof, grade could be produced both in the laboratory and in a plywood mill. The glue costs for plywood of this type are relatively low and there may be a possibility of further reductions in cost when the system becomes more familiar to plywood producers.

Literature References

(1) Bikerman, J., "Foams: Theory and Industrial Applications," pp. 130-283, Rheinhold Publishing Corp., New York (1955).

(2) Bornstein, L., Chemical Foam Extension of Urea-Formaldehyde Glues, *Forest Prod. J.*, Vol. 8, No. 10, pp. 51A-54A (1958).

(3) Hardwood Plywood, Commercial Standard 35-56, p. 11, U.S. Government Printing Office, Washington, D.C. (1956).

(4) Lähteemäki, R., Foaming of Extended Urea-Glue, Engineering Thesis, State Institute of Technology, Helsinki, Finland (1959).

(5) Manegold, E. "Foam," p. 108, Heidelberg (1953).

(6) Mori, S., and S. Imura, Studies on Foaming Adhesives, VII. Durability Test on the Foaming Urea-Resin Glued Plywoods by Using a Weather Meter, *J. of Japan Wood Res. Soc.*, Vol. 5, No. 3, p. 99 (1959).

(7) Plotnikova, G., Foamed Urea Glue, *Derev. Prom.*, Vol. 12, pp. 5-8 (1956).

(8) Smith, E., and H. Taylor, Use of Accelerators in the Curing of Phenolic Resin Adhesives, *Adhesives and Resins*, Vol. 4, No. 5, pp. 70-74 (1956).

(9) Sodhi, J., Dependence of the Bonding Strength of Phenol-Formaldehyde Resins of Various Condensation Stages of Viscosity, *Holz als Roh- und Werkstoff*, Vol. 8, 303-07 (1956).

(10) Ziegler, J., Mechanized Foaming of Adhesives, *Forest Prod. J.*, Vol. 9, pp. 233-35 (1959).

Adhesive Change Adds Efficiency At Plywood Plant

Melurac 260 glue mix is poured into the reservoir of a Merrit jointer at Jamestown Veneer and Plywood Company plant.

For over a year Jamestown Veneer and Plywood Co., Jamestown, N.Y., a producer of quality hardwood, plywood and allied products, has been using a new splicer adhesive that shows important improvements over the resin used previously. The adhesive formerly in use had a short pot life, making it necessary to stop the plant's Merritt and Diehl jointers for washing about half way through each eight hour shift. The company found that the pot life of American Cyanamid's Melurac 260 Melamine-Urea resin was about twice as long, eliminating the necessity for a wash-up during the shift.

Bob Ralph, quality control supervisor at the plant, also found that the Melurac 260 resin allows a much longer assembly time than the adhesive previously in use. Glue spread at the jointer was found to provide a very satisfactory bond after storage of the plywood veneers for two days at 80°F.

Using the new adhesive, Jamestown's splicer can operate at 85 feet per minute, with the upper heater strip at 350°F. and the lower near 300°F. The low temperatures minimize the danger of scorching heat-sensitive veneers. The resin is also said to produce excellent adhesion when splicers are operated well in excess of the 85 foot-per-minute rate.

Melurac 260 is a one package melamine-urea powdered adhesive, formulated for use on modern tapeless veneer splicers. It contains a small amount of shell flour to give the glue line a color closer to that of wood.

Veneer can be fed through the splicer at a rate of 85 feet per minute since the plant switched adhesive formulations.

Application of adhesive to the edge of the veneer in the jointer is shown. Bonded veneers are stored two days at 80°F.

NEWS of the ADHESIVES WORLD

Jerry Conrad

Steve Proops

Imperial Adhesives Formed

A new adhesive company, Imperial Adhesives, Inc., has been formed by Jerry Conrad, named president of the new firm, and Steve Proops, who will be vice-president. The company's new adhesive and chemical plant is located in Cincinnati, Ohio, and is producing latex and solvent compounds. The new plant, with 25,000 square feet of floor area, will specialize in the manufacture of natural rubber, reclaim rubber, neoprene, nitrile, acrylic, vinyl latex, and solvent adhesives. According to the company, hot melts, polyester, and epoxy compounds will also be manufactured as well as customer emulsions and dispersions for the trade.

Former Associations

Mr. Conrad, president of Imperial Adhesives, was formerly technical director of Adhesives Products Corp., and its affiliates Rubba, Inc., and Java Latex & Chemical Corp. Mr. Proops, vice-president of the new adhesives company, previously had been general manager of Anchor Adhesives Corp., also an affiliate of Adhesive Products Corp. In forming Imperial Adhesives, both men felt that the technical, economic, and service requirements of the Midwest could be better served by locating an adhesive plant in this growing industrial area.

Chem Seal Names Two

Chem Seal Corp., Los Angeles, Calif., has appointed Robert Olsen as plant manager and W. J. Denzel as manager of inside sales. Fred W. Eber, president of Chem Seal, states that the appointments are part of the current expansion program of the company, which manufactures adhesives, sealants and coatings for construction, marine, aircraft, and other industries. Prior to his present appointment, Mr. Olsen had headed Chem Seal's Compounding Department and had also served in the Technical Service Division. Mr. Denzel, previously associated with a carloading firm, will handle telephone orders for all the company's products.

National Starch Plans Australian Firm

National Starch & Chemical Corp., New York, N.Y., has joined with Jordan Chemical Works (A'sia) Pty. Ltd., Sydney, Australia, to form a jointly-owned company, Jordan-National Co., Pty., Ltd., to manufacture and sell vinyl polymers and various adhesives made in the United States by National Starch. Manufacturing facilities and executive offices of Jordan-National will be located in Sydney. Max Glaser, managing director of Jordan Chemical Works, has been named to serve in a similar capacity for the new concern.

Jordan Chemical, a publicly-owned company, is reported to be a leading producer in Australia of synthetic resins and chemicals which are sold principally to the printing ink, paint, and surface coating trades.

Meredosia Unit On Stream

The 14 million pound per year capacity polyvinylidene chloride resin plant of National Starch at Meredosia, Ill., recently went on stream. The facility is in commercial production of Resyn 3600, an aqueous dispersion of vinylidene chloride copolymer. The new plant is the latest addition to the firm's multiple plant operations at Meredosia, which also includes one of the world's largest polyvinyl acetate emulsion facilities. According to the company, the combined productive capacity at Meredosia now exceeds 30 million pounds annually.

3M Plans Australia Unit

Minnesota Mining & Manufacturing Co., St. Paul, Minn., has announced its plans for the early construction of a coated abrasives plant in Australia. The new plant, to be located at the site of the present 3M facility at St. Mary's, New South Wales, is expected to be on stream early in 1962.

Borden Unit in Canada

Borden Chemical Company (Canada) Ltd., Ontario, Canada, is constructing new manufacturing facilities for the production of polyvinyl acetate emulsions, polystyrene and acrylic emulsions, and liquid urea resins. The expansion program includes a recently completed warehouse building, located adjacent to existing manufacturing facilities, which has doubled the company's storage area. The new project, said to involve an investment of $250,000, is now in progress. Gerald J. Ray, president of the Canadian firm, states that Canadian product additions follow the production pattern of the world-wide Borden Chemical operations. He adds that all products produced in Canada are for Canadian consumption.

Chief markets for the new resins and emulsions are the adhesives, plywood, paint, and particle board industries, the president points out. In addition, other principal uses for the chemical materials are floor wax emulsions, paperboard and fabric coatings, leather finishes, wet strength additives and resins, and surface coatings. The expansion program is expected to be completed early in 1961.

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Avery Marks 25th Year For Label Industry

The 25th anniversary of Avery Label Co. was commemorated recently in Monrovia, Calif., at a celebration by key management personnel of Avery Adhesives Products, Inc., its divisions, subsidiaries and affiliated companies throughout the world. The event also marked the 25th anniversary of the founding of the pressure-sensitive label industry. According to a company spokesman, the selection of the site for the Silver Anniversary tribute is fitting, because it was made possible by a series of inventions by R. Stanton Avery.

As part of the Silver Anniversary commemoration, Avery dedicated its new Cleveland, Ohio, and New Brunswick, N. J., plants on October 22 and 29, respectively. On view during each of the celebrations in Avery Label's domestic plants was an exhibit showing the history of the pressure-sensitive label industry, including parts of the original machine developed by Mr. Avery, who is now board chairman of Avery Adhesive Products, Inc.

Looking at the growth of the industry he originated, Mr. Avery reflected, "We have continually found new applications for pressure-sensitive labels and similar items. Twenty-five years ago, all our labels were of one size; today the types, variety, shapes and sizes number tens of thousands. Furthermore, new adhesive formulations are making it possible to apply self-adhesive materials to virtually any surface." In noting the Silver Anniversary commemoration, messages from world and national figures were received, congratulating Mr. Avery for his role in founding the industry.

AMA Packaging Show

A preview of packaging in the next quarter century will be a feature of the 30th National Packaging Exposition of the American Management Association, to be held on April 10 to 13 at the Lakefront Exposition Hall in Chicago, Ill. The AMA expects the 1961 exposition to be its largest, occupying more than 150,000 square feet of space. Displays by more than 330 exhibitors will show the latest in packaging machinery, materials, methods, and services. The total worth of the exhibits will be about $6 million, and the AMA expects over 30,000 visitors to attend the exposition as well as the National Packaging Conference, which will be held under the same roof.

G. R. Milne

Air Reduction Merges Chemical Divisions

All activities of Air Reduction Co., Inc., New York, N.Y., in the industrial chemical field have been consolidated into a single operating division called Air Reduction Chemical and Carbide Co. G. R. Milne has been named president of the new division, which consolidates three chemical divisions of Air Reduction: Air Reduction Chemical Co.; Colton Chemical Co.; and National Carbide Co.

John A. Hill, president of Air Reduction Co., states that the consolidation will improve the company's effectiveness in the industrial chemical field by providing a stronger competitive front, greatly increased marketing strength, and more effective coordination of its activities. The sale of polyvinyl acetate emulsions will continue to be handled by the Colton Polymers Department. Vinyl monomers and other acetylene chemicals will be marketed by the Organic Chemicals Department. Both departments will market Vinol polyvinyl alcohol.

In addition to Mr. Milne, the officers of the new division are: B. R. Krashin, vice-president, marketing; R. T. Lund, vice-president, operating; R. A. Speck, vice-president, distribution; J. M. Tinnon, vice-president, engineering; and F. E. Evers, controller. C. J. McFarlin, president of Air Reduction Chemical Co., will join the corporate forward planning group.

Darling Names Kimball

Darling & Co., Chicago, Ill., has appointed R. E. Kimball as Eastern sales representative for its Glue Division. He succeeds R. R. Jones, who has been transferred to the firm's Fertilizer Division.

Anderson Elected

Elmer L. Anderson, president of H. B. Fuller Co., St. Paul, Minn., was elected governor of the state of Minnesota in the November, 1960 election. He is one of the two Republicans elected into state office in Minnesota in 1960. Mr. Anderson was born in 1909. He attended the University of Minnesota School of Business Administration, and joined H. B. Fuller in 1934, becoming president of the firm in 1941. Governor-elect Anderson has been active in civic and political affairs in Minnesota for many years, and in 1949 he was elected a state senator.

Foster Joins Borden

Richard Foster has joined Borden Chemical Co., New York, N.Y., as a sales representative for its Consumer Products Department. He will make his headquarters in Atlanta, Ga., and will be responsible for the sale of Borden Chemical's complete line of consumer adhesives and garden hose products in Georgia, Florida, and Alabama. Mr. Foster attended the University of Georgia and the Atlanta Law School. Prior to joining Borden, he was associated with Reynolds Metal Co., Olin Mathieson Chemical Corp., and with his own business firm.

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R. S. Holdsworth

Joins Dewey & Almy

Dr. Robert S. Holdsworth has joined Dewey & Almy Chemical Division, W. R. Grace & Co., Cambridge, Mass., as manager of the can sealing compound research laboratory. Dr. Holdsworth received a B.S. degree in chemistry from Western Kentucky State College in 1944, and his Ph.D. in physical chemistry from the University of Rochester in 1947. Prior to joining Dewey & Almy, he was associated with Escambia Chemical Corp. and Naugatuck Chemical Division of U.S. Rubber Co. Dr. Holdsworth is a member of the American Chemical Society and the Society of Plastics Engineers.

Pigg Forms Sales Firm

A newly-formed company, Pigg Company of Canada, 1200 Burnside St., Montreal, Quebec, Canada, is offering its facilities to American businessmen interested in exploring the Canadian market as a potential outlet for goods and services. According to T. W. Deachman, president of Pigg, the firm is headed by a team of established experts in sales, general management, finance, advertising, and public relations, and is prepared to go well beyond the area occupied by conventional manufacturers' representatives.

Borden Names Saggese

Joseph M. Saggese has been named assistant manager of the Casein Department of Borden Chemical Co., New York, N.Y. He will be responsible for purchasing and trading activities of imported casein and other special commodities. Mr. Saggese received a B.S. degree from Fordham University in 1953, where he majored in finance. He was formerly associated with Wessel Duval & Co., and with North American Continental Co. as a commodity trader.

Eastman Appoints Lee

Eastman Chemical Products, Inc., Kingsport, Tenn., has appointed C. R. Lee to its Chemical Division sales office in Skokie, Ill. Mr. Lee, who will represent the firm in the selling of its industrial and specialty chemicals in the Metropolitan Chicago area, joined the Eastman organization in 1939 as a chemist in the Synthetic Chemicals Department at Kodak Park, Rochester, N.Y. Prior to his present assignment, Mr. Lee held the position of sales coordinator for Eastman Chemical Products.

AMSCO Names Two

American Mineral Spirits Co., Chicago, Ill., has appointed Robert G. Snowden to the position of manager of special products of its Southern California Division, and has named Peter C. Thompson its sales representative in the Texas-Oklahoma-New Mexico area. Mr. Snowden will be responsible for the distribution in Southern California of AMSCO's line of related chemicals, and Mr. Thompson will handle sales of technical naphthas, petroleum solvents, and waxes.

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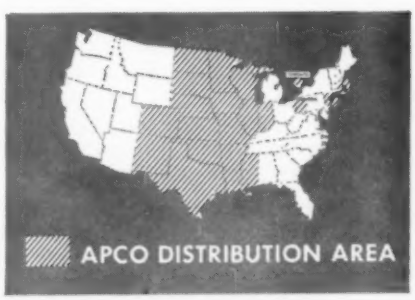

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names in the news

Dr. H. Neal Dunning has joined General Mills, Minneapolis, Minn., as head of the newly-created Physical Chemistry Department, and **Dr. James M. White** has joined the company as project leader in physical chemistry research.

Frank K. Greenwall, board chairman of National Starch & Chemical Corp., New York, N.Y., has been elected president of Keep America Beautiful, Inc., a public service organization.

Dr. Benjamin L. Souther has retired from the Chemicals and Plastics Division of Food Machinery & Chemical Corp., New York, N.Y., and is now consultant to the firm's Central Chemical Research Department

Louis M. Strottman, formerly Cincinnati, Ohio, district manager for Formica Corp., has been assigned to the firm's Contract Sales Department. **J. Allen Montei,** previously assistant manager of Formica's Los Angeles district office, succeeds Mr. Strottman.

Robert W. Longley has been appointed a research biochemist at the Central Research Laboratory of General Mills, Minneapolis, Minn.

Dr. R. Emerson Lynn, Jr. has been named manager of program planning for B. F. Goodrich Chemical Co., Cleveland, Ohio.

Thomas A. Marshall, Jr., previously senior assistant secretary of the American Society of Mechanical Engineers, has been elected executive secretary for the American Society for Testing Materials, Philadelphia, Penna. **Fred F. Van Atta,** formerly assistant secretary of ASTM, was elected treasurer of the society. **Robert J. Painter,** previously executive secretary and treasurer of ASTM, will continue as a consultant to the executive secretary.

Robert W. Johnson, Jr. has been named president of Johnson & Johnson, New Brunswick, N.J., succeeding **George F. Smith,** who has retired.

Drs. Paul J. Berrigan and **Donald W. Thompson** have been added to the technical staff at the Research Center of Shell Development Co., Emeryville, Calif.

George Brannick, Jr., previously with Reichhold Chemicals, Inc., has joined Schenectady Varnish Co., Inc., Schenectady, N.Y., as a research chemist.

Alan Corry, formerly with General Dynamics Corp., has joined the staff of Chamberlain Laboratories, Stow, Ohio, as a research engineer.

S. M. Spencer has been named by Bemis Bro. Bag Co., St. Louis, Mo., to succeed retiring **Philip C. McGrath** as manager of its St. Louis bag plant and Sales Division. **S. D. Robey** has been appointed manager of the Omaha, Nebr., plant and Sales Division of Bemis Bro.

Dr. Robert Fulton has joined the laboratory staff of the Adhesives, Coatings, and Sealers Division of Minnesota Mining & Manufacturing Co., St. Paul, Minn.

Irving Bederson has been appointed sales manager of Anchor Adhesives Corp., Flushing, N.Y.

Myron Altman, previously with Elm Coated Fabrics Co., has joined Pantasote Co., Passaic, N.J., as a sales representative.

G. M. Chidester, chief of the U. S. Division of Pulp and Paper, U. S. Forest Products Laboratory, Madison, Wisc., has been named the recipient of the 1961 TAPPI Medal.

Robert F. Daily, legal counsel for A. E. Staley Manufacturing Co., Decatur, Ill., has been elected secretary of the company, succeeding **Ray C. Scherer,** who retired after 48 years service with the firm.

Jerome G. Stone, president of Stone Container Corp., has been elected president of Fibre Box Association.

J. Edgar Hill, formerly with Armour & Co., has opened his own office in Buenos Aires, Argentina, for the Argentine Eximport Co., S.R.L.

Richard H. Baltimore has joined Formica Corp., as a sales representative in Los Angeles, Calif.

Walter Hullinger, vice-president of sales for Milprint, Inc., has been named vice-president of the National Flexible Packaging Association.

H. Wesley Hibbert, president of Pecora, Inc., Philadelphia, Penna., has been elected president of the Philadelphia Chapter of the Paint, Lacquer and Varnish Association.

Jack Woods has been elected vice-president and general sales manager of General Converting & Laminating Corp., Oakland, Calif.

I. Wayne Keller, vice-president and general manager of international operations for Armstrong Cork Co., Lancaster, Penna., has been named a director of the company. **Walter E. Hoadley** has been appointed vice-president and treasurer.

Joseph J. Tomlinson, of the General Chemical Division, Allied Chemical Corp., New York, N.Y., has been elected to the board of governors of the Chemical Specialties Manufacturers Association.

Barry Davis has been named product manager for Food Machinery & Chemical Corp., South Charleston, West Va.

John J. Phelan has been appointed director of creative packaging for Mead Packaging, Inc.

Robert P. T. Young has been named manager of the Organic Chemical Department of the Chemical Division of Glidden Co., Cleveland, Ohio.

Ennis P. Whitley, vice-president for distribution of The Dobeckmun Co., Cleveland, Ohio, has retired after 16 years with the company.

Gordon B. Smith has joined Scott Paper Co., Chester, Penna., as a process engineer in its Foam Division.

David W. True has been named a sales trainee in the Sales Department of Shawinigan Resins Corp., Springfield, Mass.

William E. Essery, formerly with Mid-West Abrasive Co., has joined the Coated Abrasives Division of Armour Alliance Industries, Alliance, Ohio, as manager of sales administration.

Richard A. Reck has been appointed chief chemist at Armour Industrial Chemical Co., Chicago, Ill.

Seaporcel Gets License

Seaporcel Metals, Inc., Long Island City, N.Y., has obtained a license from North American Aviation, Inc. to use a newly-developed coating, Cermet N16, and a related coating process for protecting metals subject to extraordinary temperature extremes. The licensing agreement provides for continued technical cooperation between the companies. It also permits Seaporcel to render technical recommendations and furnish sample parts to meet a variety of industry problems relating to metals subject to temperature extremes.

Cermet N16 was developed by the Columbus Division of North American Aviation to fully protect a variety of metals used in industry in operational circumstances under temperatures ranging from —65° through 2000°F. The material is said to provide substantially greater protection than is possible with other materials and processes, and at a considerably lower cost. According to Seaporcel, the new coating is adaptable to such metals as low carbon steel; tool steel; cast steel; enameling iron; cast iron; copper; stainless steels; and such exotic metals as molybdenum, columbium, and tungsten.

Alpha Company Formed

A new firm, Alpha Research & Development, Inc., Blue Island, Ill., has been established to provide research facilities and personnel to industry and government. According to Robert L. Patrick, president of Alpha, the company's area of proficiency includes chemistry, physics, mathematics, electronics, printed circuitry, dynamics and cushioning, and specialized services such as reliability studies and toxicological determinations. In addition, the firm will also concentrate on the application of materials to particular end uses, Mr. Patrick states.

Robert L. Patrick

Monochem Site Selected

Borden Co., New York, N.Y., and U.S. Rubber Co., New York, N.Y., have selected a site near Geismar, La., for the construction of a $50 million complex of chemical plants which will convert hydrocarbons into more than a dozen chemical products. It is on this site, about 850 acres of land, that the jointly-owned company, Monochem, Inc., will erect a major chemical manufacturing unit using hydrocarbons as a starting point for the production of acetylene and vinyl chloride monomer. Borden and U.S. Rubber plan to erect adjacent individually owned plants which will use the output of the Monochem plant for the manufacture of other chemical products. Initially, Monochem is expected to have the capacity to produce more than 80 million pounds of acetylene and approximately 150 million pounds of vinyl chloride monomer annually. It is reported that the major initial use of the Monochem output would be in the manufacture of vinyl plastic resins which Borden manufactures in Leominster, Mass., and U.S. Rubber produces in Painesville, Ohio.

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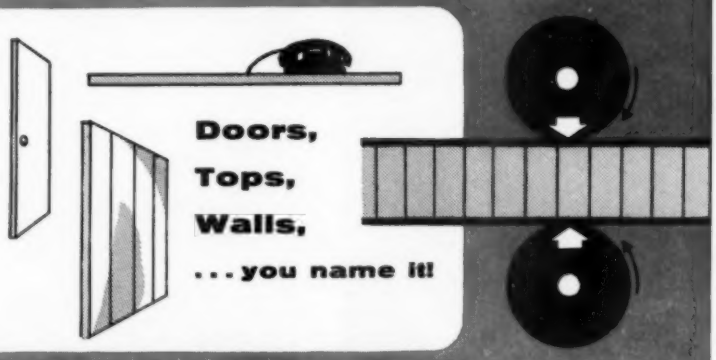

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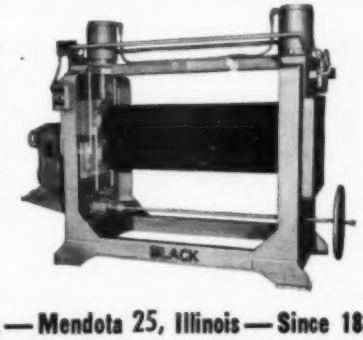

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T. G. Garren

Staley Mfg. Promotes Two

A. E. Staley Manufacturing Co., Decatur, Ill., has made two personnel promotions in its Paper Industry Sales Department. Herbert L. Roszell, Jr., was promoted to manager of dextrin and adhesive products, and Thomas C. Garren was named sales service supervisor. Mr. Roszell, a graduate of the University of Illinois, joined Staley in 1949 as a technical representative in industrial sales. Since 1955, he had been a technical assistant in the Corn Division. Mr. Garren is a graduate of Iowa State University. He joined the company in 1953 as an associate research chemist, and since 1955 he has been in the Industrial Sales Department.

D. J. O'Conor, Jr.

W. A. Smith

In New Formica Posts

Dan J. O'Conor, Jr., president of Formica Corp., Cincinnati, Ohio, has been elected a vice-president of Formica's parent organization, American Cyanamid Co., and Walter A. Smith, previously vice-president and assistant general manager of Formica, has been appointed executive vice-president of Formica Corp., a newly-created post. Mr. O'Conor, as an operational vice-president, will be responsible for the operations of Formica Corp., and of American Cyanamid's Plastics and Resins Division, Wallingford, Conn. Mr. Smith will be directly responsible for the general management of Formica Corp., including the firm's industrial plastic laminate plant in Cincinnati, the decorative laminated plastic plant in Evendale, Ohio, and the Formica Flakeboard plant in Farmville, N. C.

Plywood Group Appeals For Help

Spokesmen for the United States hardwood plywood industry told U.S. Department of Commerce officials, at a recent conference in Washington, D.C., that the industry must be stabilized if it is to prosper, and discussed steps they felt are needed to improve conditions. The conference was the 32nd of a series the Department of Commerce has held with key United States industries as part of the Government's foreign trade expansion program to determine what handicaps industries encounter in their foreign operations, and to obtain suggestions as to how they might be eased.

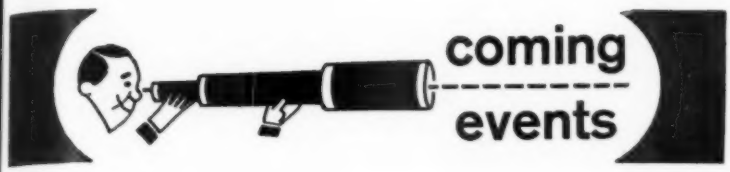
The hardwood plywood industry spokesmen urged that efforts be made to induce foreign exporters to adapt their shipments to United States market requirements. They pointed out that the supply in this country is far in excess of domestic consumption needs, with the result that both the foreign exporter and the domestic industry suffer. Domestic concerns report that their operations are being curtailed.

It was also brought out that hardwood plywood is facing stiff competition from other construction materials, and promotional efforts to stimulate use of the plywood are to be undertaken. It was recommended that an industry task force be created to work on the industry's problems along with the Department of Commerce.

Permacel Exhibiting

Four of its products will be featured by Permacel, New Brunswick, N.J., at the 1961 Plant Maintenance & Engineering Show to be held on January 30 to February 2 at the International Amphitheatre in Chicago, Ill. Products to be featured in the Permacel booth are: PA-1041 Epoxy Junction Box Mount, a two-part material designed for adhering electrical junction boxes to masonry walls, ceilings, floors, metal beams, etc.; Ribbon Dope Thread Sealant, a pipe dope in dry roll form; Concrete Coating, an epoxy resin-hardener material for waterproof coating of concrete walls, floors, stairways, etc.; and 903 Wash 'N Wipe Cloth, for washing or wiping off glass, metal, plastic, tile, or ceramic surfaces.

Personnel who will be stationed at the Permacel display include George A. Fitzgerald, president of Permacel; Robert S. Bradford, vice-president, sales; Norman P. Hickok, director of industrial products; and William Squire, division manager.



Jan. 9-11. National Symposium on Reliability and Quality Control, Bellevue Stratford Hotel, Philadelphia, Penna.

Jan. 16-19. Instrument Society of America, Winter Instrument-Automation Exhibit, Sheraton-Jefferson Hotel and Kiel Auditorium, St. Louis, Mo.

Jan. 24-27. Society of Plastics Engineers, 17th Annual Technical Conference, Shoreham Hotel, Washington, D.C.

Jan. 26-27. Engineering Institutes on Nondestructive Testing, University of Wisconsin, Madison, Wisc.

Jan. 30-Feb. 2. Plant Maintenance and Engineering Show, International Amphitheatre, Chicago, Ill.

Jan. 30-Feb. 3. American Society for Testing Materials, Committee Week, Netherland Hilton Hotel, Cincinnati, Ohio.

Feb. 7-9. Society of the Plastics Industry, 16th Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Ill.

Feb. 9-10. Engineering Institutes on Packaging Industrial Products, University of Wisconsin, Madison, Wisc.

Feb. 9-11. Fifth Annual Home Improvement Products Show, New York Coliseum, New York, N.Y.

Feb. 13-17. American Management Association, Packaging Management Course, Hotel Astor, New York, N.Y.

Feb. 19-23. American Institute of Mechanical Engineers, Annual Meeting, St. Louis, Mo.

Feb. 19-23. Technical Association of the Pulp & Paper Industry, 46th Annual Meeting, Commodore Hotel, New York, N.Y.

Feb. 20-23. American Pulp and Paper Association, Annual Convention, Waldorf-Astoria Hotel, New York, N.Y.

Feb. 21. Laminated Foil Manufacturers Association, Annual Luncheon Meeting, Yale Club, New York, N.Y.

Feb. 22-24. Material Handling Institute, Pacific Coast Show, Cow Palace, San Francisco, Calif.

Feb. 23-24. Chemical Institute of Canada, Protective Coatings Division Conference, Toronto, Ontario, Canada.

Feb. 26-Mar. 1. American Institute of Chemical Engineers, National Meeting, New Orleans, La.

March 5-9. American Society of Mechanical Engineers, Aviation Conference, Statler Hilton Hotel, Washington, D.C.

March 9-10. Hardwood Plywood Institute, Spring Membership Meeting, Shoreham Hotel, Washington, D.C.

March 13-17. National Association of Corrosion Engineers, Annual Conference, Statler Hotel, Buffalo, N.Y.

March 20-24. American Society for Metals, 12th Western Metal Congress and Exposition, Pan Pacific Auditorium, Los Angeles, Calif.

March 21-30. American Chemical Society, 139th National Meeting, St. Louis, Mo.

March 23-24. Committee D-14 on Adhesives, American Society for Testing Materials, Washington, D.C.

Portrait of

NICHOLAS J. DeLOLLIS

Recently elected vice-chairman of ASTM's D-14 Committee on Adhesives, Nicholas J. DeLollis is a materials engineer at Sandia Corporation, Albuquerque, N.M. He is responsible for adhesive and sealant development and application in the perfection of strategic and tactical weapons designed around the explosive systems conceived by the AEC nuclear research laboratories.

A graduate of Clark University in his home town of Worcester, Mass., Mr. DeLollis went to work for the National Bureau of Standards in 1941. Assigned to various groups within the NBS, he spent approximately six years in the Organic Plastics section doing research on synthetic resins.

Transferred to the Ordnance Division, which eventually became the Department of Defense's Diamond Ordnance Fuze Laboratory, Mr. DeLollis continued his work on synthetic resins, orienting it towards Ordnance requirements. These included the use of adhesives, sealants and materials for potting, encapsulation and molding. He joined Sandia, a non-profit subsidiary of Western Electric Co., in 1956.

Author and co-author of numerous articles on adhesives and related topics, Mr. DeLollis has contributed the chapter on "Structural Metal Adhesives" to Dr. Irving Skeist's forthcoming book on structural adhesives.

By MELVIN NORD

Transferring Pressure-Sensitive Masses

U. S. Patent 2,946,370, issued July 26, 1960 to William H. Muttera, Jr., assigned to W. H. Brady Co., describes a method of applying pressure sensitive adhesive masses to thin pliant articles such as fabric labels and masks.

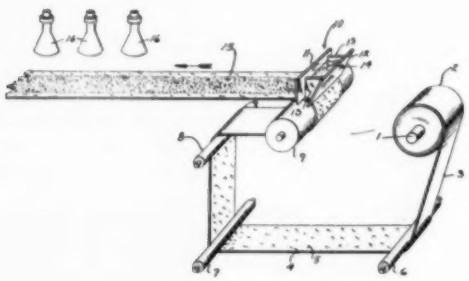


Figure 1

There is shown in Figs. 1 and 1a, a rotatable supply spool (1) that carries a supply roll (2) of liner paper from which a web(3) is withdrawn. The surface (4) of the web (3) has been treated with a release coating (5). The coating constitutes a film approximately one-half mil thick, and the liner paper forming the web (3) is selected from a stock that is dense and non-absorbent, so that the coating will stand on the surface as a uniform film. A parchment paper is a typical example of that which may be employed.

The web is led about a guide roll (6) and then about a second guide roll (7), from which it leads upwardly about a third roll (8). From the third roll the web passes horizontally toward and about a resilient fountain roll (9), formed of rubber. An adhesive fountain (10) is disposed directly above fountain roll, and consists of a vertically disposed doctor blade (11), a back plate (12), and a pair of side dams (13).

A pressure-sentitive adhesive (14) carried in a volatile vehicle is deposited in the fountain, and as the release coated surface (4) of the web is drawn underneath and past the fountain the adhesive is deposited upon the release coated surface. Proper metering of the adhesive (14) is had by adjustment of the doctor blade. A typical commercially available adhesive has been employed in the practice of the invention and is described as a polyvinyl ethyl ether in a suitable volatile vehicle together with a tackifier and a filler as deemed appropriate.

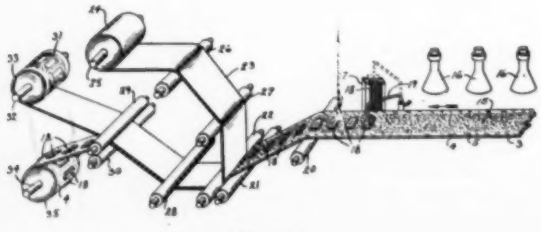


Figure 1a

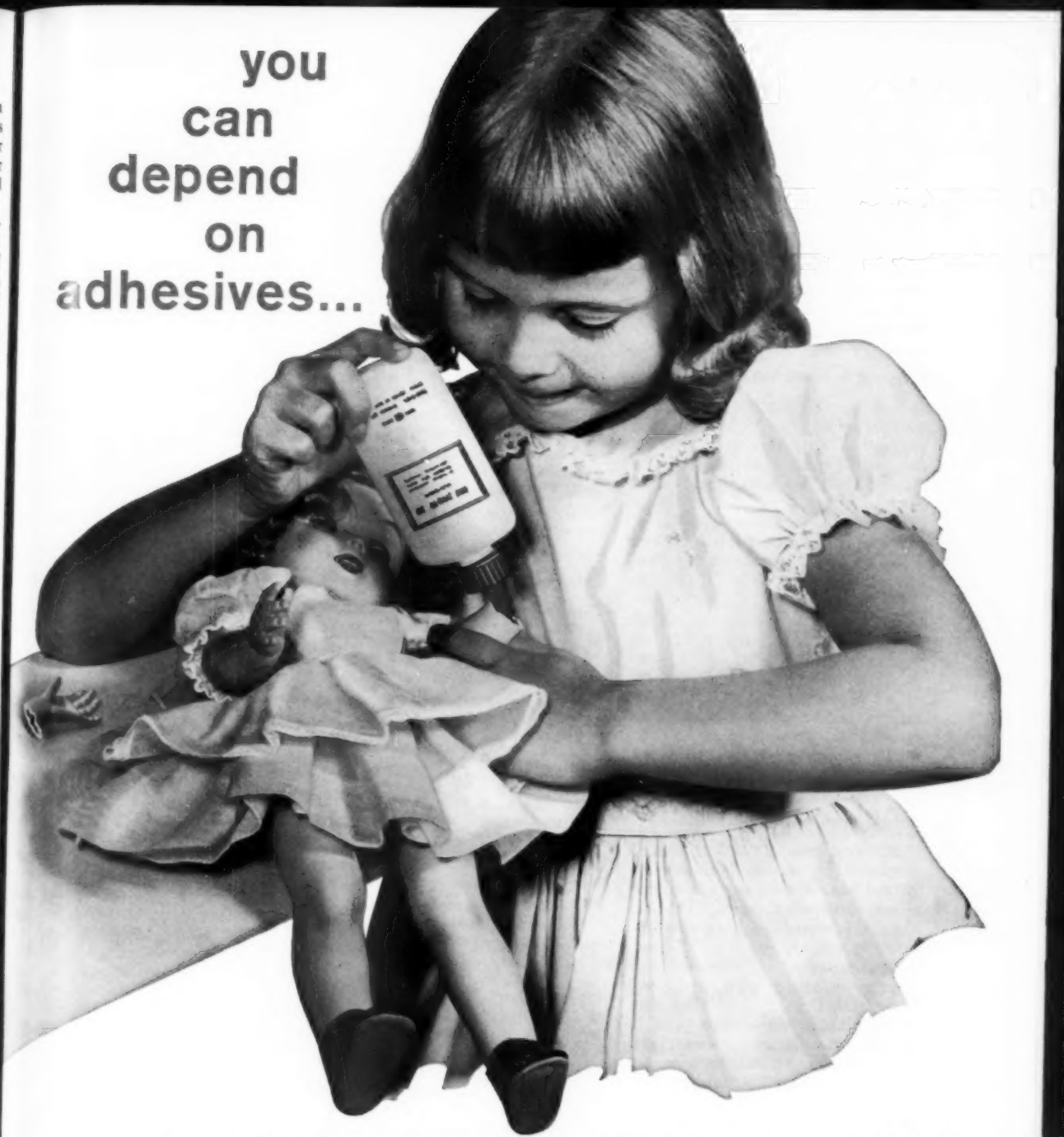
The web is drawn from the fountain roll with its adhesive layer (15) toward and beneath a bank of radiant heat lamps (16). Heat drives the volatile vehicle from layer of adhesive, so that the adhesive (15) "sets up" upon the release coated surface as a permanently tacky pressure-sensitive layer.

The apparatus shown in drawings is a single complete unit, that which is set forth in Fig. 1a being a continuation of that set forth in Fig. 1. Hence, as the web emerges from beneath the bank of heat lamps, it passes alongside a hopper (17) containing thin separate individual metallic labels (18). A pneumatic dispenser (19) that transfers labels from the hopper to the adhesive layer is shown schematically.

With the labels placed upon the web in an orderly closely spaced array, such that substantially all of the adhesive layer is masked by the labels, the web is carried across a roll (20) and then toward and over another roll (21). From the latter roll, the web progresses to a closely adjacent laminating roll (22) which introduces a web (23) of transfer paper to the surface (4), to engage the remaining exposed adhesive. The transfer paper is supplied from a roll (24) carried on a spool (25) and is drawn over a pair of idler rolls (26 and 27) to the laminating roll (22).

As the transfer paper web (23) is brought into engagement with the web, the exposed adhesive temporarily laminates the two. These laminated webs (3 and 23) are drawn about a guide roll (28) toward and between a pair of squeeze rolls (29 and 30). The squeeze rolls press the webs (3 and 23) tightly against one another to insure that the entire area of exposed adhesive is contacted by the transfer paper web under substantial pressure.

As the webs are drawn from between the squeeze rolls, they are moved in divergent directions so as to split and separate one from the other. The adhesive will have a greater affinity for the surface of the transfer paper web than for the release coated surface of the web (3). In this way, the adhesive not covered by the labels will be cleanly separated from the web (3) and carried away with the transfer paper



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web. The transfer paper together with the transferred adhesive, indicated by the number 31, is wound about a take-up spool (32) into a roll (33). The web (3), which no longer has any exposed adhesive layer, is wound upon a take-up spool (34) into a completed roll of labels (35). The surface of the web either exposes labels or the release coating, and as such the roll (35) presents a convenient packaging for the labels.

Foamed Rubber Latex

U. S. Patent 2,945,826, issued July 19, 1960 to Lilian F. Everett and assigned to The Hairlok Co. Ltd., describes a method of producing a foamed rubber latex containing gelatinized starch.

A foamable and coagulable liquid mix containing rubber in suspension is first prepared. To this mix is added one to eight per cent of a finely-divided ungelatinized starch. The mix is then formed into a foam, and the foam is caused to set to form a coagulated cellular mass, at a temperature insufficient to cause the gelatinization of the starch. The mass is then heated to a temperature sufficient to cause bursting of the starch grains and gelatinization of the starch.

Fabric Laminate

U. S. Patent 2,949,393, issued August 16, 1960 to Maitland W. Alford and Arthur R. Brearly, assigned to British Celanese Ltd., provides a laminate consisting of three fabric layers.

The two outer layers consist of cellulose triacetate yarn, the acetyl value being from 59 to 62.5 per cent. An interlining fabric is bonded to the two outer layers by means of a monomeric cyclic amide of an omega-amino paraffinic monocarboxylic acid, at least part of which is dissolved in the cellulose triacetate.

Pressure-Sensitive Adhesive

U. S. Patent 2,947,650, issued August 2, 1960 to James S. Gerhardt and William F. Fowler, Jr., assigned to Eastman Kodak Co., discloses a new pressure-sensitive adhesive.

The adhesive contains 20-50 per cent tetrahydroabietyl alcohol, 20-35 per cent inert pigments and fillers, and 30-50 per cent of a copolymer prepared from a monomeric mixture containing 50-70 mole per cent styrene and 30-50 mole per cent 2-ethylhexyl acrylate.

Removal of Metal Ions from Gum Arabic

U. S. Patent 2,950,195, issued August 23, 1960 to George R. Hodgins, Erwin DiCyan, and Robert Timmerman, assigned to Litho Chemical & Supply Co., Inc., describes a method of preparing a precipitate-free aqueous gum arabic solution, containing approximately 73 per cent water and 22 per cent gum arabic, and having not more than 70 parts per million of calcium ions per ml.

The starting material contains 0.7 per cent calcium and 0.6 per cent magnesium, 28.3 per cent gum arabic, 71.5 per cent water, and 0.2 per cent phenol. An amount of $(NH_4)_2HPO_4$ is added which is the stoichiometric equivalent of the calcium and magnesium contents. Ammonium hydroxide is then added to raise the pH to 8.5-10. This precipitates out calcium and magnesium phosphates.

Coated Fibrous Products

U. S. Patent 2,940,875, issued June 14, 1960 to Frederick A. Smith and Thomas H. Welch, assigned to Union Carbide Corp., provides an adhesive silicone-coated fibrous product. It consists of a fibrous base material coated with a silicone elastomer made from a stabilized, devolatilized, unfilled, curable dimethylsiloxane which is substantially free of low molecular weight dimethylsiloxanes.

Other Patents of Interest

Subject	Inventor or Assignee	Patent No.	Date
Manufacture of white cement clinker	Dyckerhoff Zementwerke	2,945,688	7/19/60
Cement composition	B. J. Service, Inc.	2,945,769	7/19/60
Adhesive bandage	Johnson & Johnson	2,946,435	7/26/60
Self-hardening alkali — and acid-proof water glass cements	Farbwerke Hoechst A. G. vormals Meister Lucius & Bruning	2,946,695	7/26/60
Warp sizing process	National Starch & Chemical Corp.	2,946,705	7/26/60
Adherent electroplating on titanium	Cleveland Pneumatic Industries, Inc.	2,946,728	7/26/60
Method of solder bonding	Philco Corp.	2,947,079	8/2/60
Gum-applying apparatus for labeling machines	Geo. J. Meyer Mfg. Co.	2,947,433	8/2/60
Pressure-sensitive adhesive	Johnson & Johnson	2,947,710	8/2/60
Apparatus for making a laminate	Philbrick - Strickland Laminates, Inc.	2,949,149	8/16/60
Splicing tape feed mechanism	E. I. duPont de Nemours & Co.	2,949,296	8/16/60
Process for rendering locust bean gum cold-water soluble	National Pectin Products Co.	2,949,428	8/16/60
Device for removing and routing putty	Carl Weber	2,949,826	8/23/60
Finishing mortars	Nya Murbruksfabrikens i Stockholm Aktiebolag	2,950,206	8/23/60
Asphalt additives	The Cincinnati Milling Machine Co.	2,950,211	8/23/60
Oil well drilling starch	Anheuser-Busch, Inc.	2,951,776	9/6/60
High temperature adhesive	W. R. Grace & Co.	2,951,778	9/6/60

Copies of any patents, including those described here, are available from the Commissioner of Patents, Washington 25, D. C., for 25 cents each. Do not send stamps.

new equipment

Environmental Test Cabinet

Com-pac Cab is a new environmental test cabinet said to have special add-on facilities for vacuum, humidity, temperature, and altitude testing. The chamber is designed for

effective low temperature operation with an adjustable temperature range from 300° to −120°F. It is reported to function with complete dependability for varied testing by merely adding optional equipment. The working chamber is 19 by 19 by 19 inches, and it is electrically welded and resistant to high pressures. According to the manufacturer, construction features include a sturdy, galvanized, all-steel finish, as well as a frostproof, multipane door in front for easy access to the chamber area, which is illuminated by a 40-watt Lumiline fluorescent lamp. The unit has a sealed-in oil supply and a built-in thermal overload protector. Its over-all dimensions are 74 by 32 by 32 inches, and it is available as a horizontal or vertical free-standing floor unit or for bench use. *Hudson Bay Co.*

E-262

Conveyor Spray Machine

The new special unit adapts the chain-on-edge principle to automatic spray finishing. The machine is equipped to handle necessary spray guns for painting from above and beneath, either or both, continuous or skip spray. Any number of workholders from a minimum of 15 can be supplied on centers to suit size of part, loading and drying time. The conveyor is constructed of sturdy channel angle and sheet steel. The chain employed is rigid roller or conveyor chain. The machine comes with a variable speed drive on the conveyor, and can be equipped with a variable speed drive to revolve the piece part. A convenient electric safety stop or control button, air filter and automatic valve lubrication is also provided along with proper exhaust capacity to match the job requirements. Bake ovens, heat lamps, gas off and cool off tunnels can also be furnished. *Conforming Matrix Corp.*

E-263

Material Level Control

The Fail-Safe Flo-Level material level control is an electronic unit for determining the presence or absence of material at a selected level in a bin, hopper, storage tank, or similar container. A sensing vane or paddle controls the generation of an electrical signal. The manufacturer reports that should any portion of the unit fail, the control contacts operate automatically to establish the same control circuit condition obtained during normal operation when the material passes the selected high or low level. The unit is available in two models, Standard Model L400 and Heavy Duty Model L400A. *Flo-Tronics, Inc.*

E-264

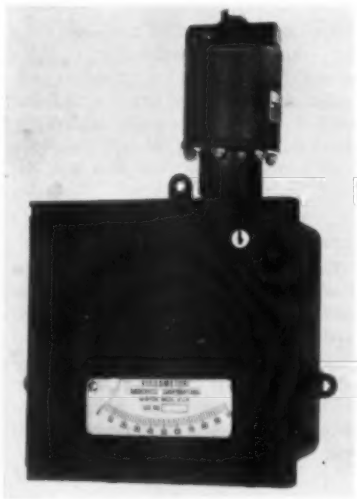
Tear Tape Attachment

All General Case Sealer Tapers can now be equipped with the necessary parts to enable them to apply a narrow strip of tear tape simultaneously with the sealing tape. The tear tape will be on the glued side of the sealing tape. The die-cut tape is provided in each end of the seal tape to enable customers to start tearing through for easy opening. Because the cases are practically undamaged by this tear-band method of opening, their reusable life is greatly increased. *General Corrugated Machinery Co.*

E-265

Viscosity Indicating Transmitter

The Viscosity Indicating Pneumatic Transmitter, Model IP, is designed for use with measuring elements that operate in open tanks, pressure or vacuum vessels, or in pipe lines. The unit receives an electrical signal from a measuring element and provides a 3 to 5 psi output in addition to indicating viscosity. This air signal is said to permit the use of all types of pneumatic control and makes it possible to use the manufacturer's viscometers with



any other firm's pneumatic receivers and controllers. In addition, with suitable transducers or converters, various electric receivers can be used with the manufacturer's viscometers. *Department N76, Norcross Corp.*

E-266

Continuous Rotary Mixers

The rotary mixer, available in four models, is specifically designed to accurately meter and blend high standard quality sealant materials, and is said to insure that their ultimate physical properties are consistently obtained in production. The mixer meter is automatic in operation, being filled from the original container by powered pumps. To change ratio, a sleeve of different size is inserted in one cylinder. Ratios of 4 parts per 100 by volume to 100 parts per 100 are available. The mixing head is driven by a rotary air motor and equipped with a tachometer. It may be cooled by exhaust air from the motor, by ice water, or by refrigerated liquid, depending upon the material and individual requirements. The manufacturer states that pumps, gages, hoses,

valves, coolants, etc., are custom selected for each usage of the machine, thereby assuring the highest efficiency and the most thorough consistent mixing. The available mixer types are: Model 1384, an air-cooled table model; Model W1384, a water-cooled table model; Model 1385, an air-cooled upright model; and Model W1385, a water-cooled upright model. *Semco Sales & Service, Inc.*

E-267

Insulation Laminator

The Scotch brand E-10 insulation laminator is designed for use with the recently announced double-coated polyester film tape, Scotch brand electrical tape No. X-1115. Insulating materials, such as mica, metal foil and fish paper, formerly held by taping or jigs may now be made pressure-sensitive, allowing easy positioning during production runs and eliminating expensive, time-consuming operation, states the manufacturer. The laminator features feed spools for the double-coated tape and the insulating material, and a take-up spool for the tape separation liner. The tape and insulation are laminated together as they are removed from the dispenser. *Minnesota Mining and Mfg. Co.*

E-268

Jet Spray Gun

The Plasmatron is a hand-held plasma jet spray gun which is used to spray deposit many types of materials with melting points between 300° and 30,000°F. The new spray and spray nozzle design is said to permit the spraying of epoxy powders at will. With melting points of but 300°F., epoxies have formerly been considered impossible for plasma spray treatment, the manufacturer reports. In addition, such materials as zinc, lead or soft solder obtainable in a powdered form, may be readily sprayed. The high purity of the sprayed materials is said to be assured by operation of the spray equipment with inert gases. *Plasmadyne Corp.*

E-269

Safety Braking System

The air-over-hydraulic safety braking system is designed for emergency stopping of in-running rolls as used in the rubber and plastics industries. The system is said to be readily applicable to existing equipment to enable it to meet safety codes and regulations that require safety stopping devices to protect the operator when safety guards are impracticable. The safety braking system consists of an external-shoe type

hydraulic brake, and a coordinated control package, that is operated by normal plant air pressures. A power cluster multiplies the system air pressure to a higher hydraulic pressure. The brake sets to stop the equipment when a safety switch, mounted above the roll, is tripped. A reserve of air pressure sufficient to make a number of emergency stops is normally maintained in the control unit, independent of continuous plant supply. Five sizes of brakes, to cover the entire range of required torques, are available. *Wagner Electric Corp.*

E-270

Analytical Program

Analysis of samples, 20 microliters or less in size, is said to be possible with the new Ultramicro Analytical Program. According to the manufacturer, the system permits accurate analysis of minute samples, is precise, dependable, and economical. Key to the program is a special self-emptying ultramicro cuvette, which requires only 100 microliters of sample solution but provides a full 1.00 cm light path for a spectrophotometer beam. The cuvette carrier orients the optical faces of the cuvette with respect to the spectrophotometer. The manufacturer reports that other elements in the program are a specialized microcentrifuge, a precision ultramicro titrator, and 12 analytical procedures. A set of 12 clinical procedures is also available, complete with its own set of reagents and volumetric dispensing equipment. The manufacturer claims that because the Ultramicro Analytical Program integrates perfectly with an instrument routinely used in many laboratories, adoption of the ultramicro techniques does not require purchase of special instrumentation which will lie idle when macro determinations are being made. *Coleman Instruments, Inc.*

E-271

Heat Seal Patcher

Model H-I Americana is said to be the only hand-operated heat seal unit currently on the market. The semi-automatic table model comes fully equipped and ready to operate. A pre-set timer release goes into action and mends within five to ten seconds, depending on the size of the hole being treated. Pad size of the unit is 5"x6", top heat 950 watts, input 115 volts AC. It requires a table area of only 10½"x24". To match the linens, institutional garment, etc., the manufacturer carries a line of over 75 heat seal fabrics in all sizes and colors. All fabrics are pre-coated with an especially formulated heat seal adhesive guaranteed to outlast the garment being patched. *Parapatch Div., Anglo Chemical Corp.*

E-272

Gyro Plastic Mixer

The Gyro plastic mixer is said to be designed especially for blending liquid plastics and hardeners. The manufacturer reports that the mixer makes it possible to blend all pattern and tooling plastics in one-third to one-half the time required for hand mixing. Other advantages noted are: thorough blending insures uniform hardening of each mix; mixes fillers that settle to bottom of can during storage; no more soft spots in laminates or plastic castings; no more overflow in lip of cup; no splashing; keeps hands clean; can be used in any electric drill. *Plaster Supply House.*

E-273

Guide Line Light

Known as the Q-15 Guide Line Light, the model is said to project unusually sharp shadow lines to guide cutting, marking or assembling operations. The unit can project any desired number of parallel straight shadow lines, square or rectangles, or can project a single white line for use on dark materials. According to the manufacturer, Q-15 can be used, in multiple units, for veneer operations, multiple saw edging, or use in log mills. *Carter Products Co., Inc.*

E-274

book reviews

Punched Cards: Their Application to Science and Industry, (Second Edition). *Edited by R. S. Casey, J. W. Perry, A. Kent and M. Berry. Published by Reinhold Publishing Corp., 430 Park Avenue, New York 22, N.Y. 6 x 9¼ in. 697 pp. $15.00.*

Thoroughly revised and enlarged, this second edition surpasses its predecessor in describing clearly every aspect of punched card systems. All who handle large masses of data will find here the principles and methods which apply to small files or the largest, and descriptions of the entire range of cards and equipment now available. This is the only volume including both hand- and machine-sorted cards. It serves as an elementary instruction manual as well as an advanced handbook.

In addition to the mechanical techniques of punched cards and related devices, the book also shows how to find, arrange, use, store and retrieve information of any kind. Such considerations are a prerequisite to any system, and they can be applied to a simple collection of data in notebooks, on plain cards, in correspondence files, and finally to data handling by punched cards and electronic computers.

The introductory material contains sufficient information to permit an individual to set up and use a simple punched-card file. The heart of the book consists of case histories of applications, carefully selected to show what has already been accomplished. A theoretical section discusses fundamental problems in organizing information quite apart from punched-card techniques. Another section speculates on the role that punched cards and related devices may eventually play in relation to other methods. Finally, a very useful bibliography is presented on uses of punched cards in connection with scientific information.

Manipulation of Thermoplastic Sheet, Rod & Tube. *By J. M. J. Estevez and D. C. Powell. Published for the Plastics Institute by Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N.Y. 5½ x 8½ in. 148 pp. $4.85.*

This is a clear and readable survey of the principal thermoplastic materials available commercially, and of the methods by which they can be fabricated into useful goods. The substances considered are polymethyl methacrylate, polyvinyl chloride and vinyl copolymers, polystyrene and toughened polystyrene, and polythene. Detailed exposition of their properties, both starting material and end product, is followed by sections on machining, decoration and bonding.

In discussing the important subject of forming, materials are divided into two classes: those suitable for oven techniques and those suitable for vacuum forming. Further chapters deal with stamping and simple shaping aided by heat, use of air pressure and vacuum, mechanically applied pressure, and the more complex processes involving combinations of methods. Separate sections are devoted to the revolutionary development in shaping, to the vacuum forming machine, and to tool construction and design. Special topics such as the use of acrylics in the aircraft industry are also discussed. Looking to the future, the authors conclude that a permanent place in the plastics industry is assured by the unique feature of the shaping process—low tool costs permitting restricted production. This unique feature makes it competitive with injection and extrusion techniques.

Polypropylene. *By Theodore O. J. Kresser. Published by Reinhold Publishing Co., 430 Park Avenue, New York 22, N.Y. 5 x 7½ in. 268 pp. $6.50.*

Properties, production, and applications of polypropylene are brought together in this book, which is written in easy-to-understand language. It is the first book to offer information on this increasingly important thermoplastic to readers without special training in polymer chemistry. Emphasis is placed on the relationship between polypropylene development and the future of high polymers generally. Sufficient information is contained on basic principles of stereochemistry to point up polypropylene's unique qualities.

A chapter on chemistry describes the work of Professor Guillo Natta on discovery and development of the material. Sections deal with applications, present limitations and future possibilities. One entire chapter is devoted to application in the packaging industry. Salesmen of polypropylene products and purchasing agents, manufacturers, and those who lack time or specialized training to read the presently scattered literature, will find this book of extreme value.

This is the nineteenth volume in the Reinhold "Plastics Applications" series. Books in preparation will cover Alkyd Resins, Polycarbonates, Premix Molding, Blow Molding, and Plastics in Tooling.

Trade Literature

Epoxy Articles Collection. A collection of articles by experts in each of the many fields where epoxies are now playing an important part, the booklet, "Everybody Needs Epoxies," is intended to constitute a working guide to the diversified epoxy field. Individually, each article outlines the progress that has been made in a specialized market area. The series of articles, reprinted from "Modern Plastics," is an effort to provide epoxy resin users with the latest information on recent developments. Fully illustrated, the booklet includes such articles as "Ester Coatings—Variations Unlimited," "Emulsions—Why and How They are Used," "Solventless Coating—A Dream Come True," "Four Ways of Building Epoxy Jigs," "Building—Bright Future for Epoxies," "Foam—Newest Member of Versatile Family," "Tops in Floor Topping," and many others. *Shell Chemical Co.*

L-309

Laminated Insulation. "Laminated Electrical Insulating Specialties" is a folder of data sheets on the company's special compositions for electrical insulations. It lists some of the standard materials which have been accepted and used generally for this purpose, such as rag paper-Mylar film composites; Kraft paper-Mylar film composites; rag paper or fish paper-varnished cambric composite; etc. Data includes the combination, the approximate finished thickness, breaking and dielectric strength. Samples of eight flexible laminated electrical insulation materials are provided in the folder itself. *Chase-Foster, Inc.*

L-310

Chemical Specialties. Capabilities for research and development of chemical specialties are presented in this new 12-page brochure. Entitled "Progress Through Creative Research," the three-color publication concentrates on the role of research in promoting useful contributions in the general area of surface chemistry—elastomer and specialty adhesives, surface coatings for both rigid and semi-rigid substrates, and surface treatments for metals. The brochure also includes technical service information. *Hughson Chemical Co.*

L-311

Adhesives Selection and Application. A thorough discussion of the selection of adhesives, bonding techniques, testing methods and a glossary of adhesive terms is contained in this engineering bulletin. Titled Bulletin No. 701, it also includes a discussion of the character-

istic of principal adhesives produced by the manufacturer. A useful table in the bulletin lists the most common causes of bond failure and recommends remedies for such failures. The glossary of adhesives terms used in discussing uses and properties of adhesives is complete and covers terminology important to research, design and operating personnel. Illustrated with photos and sketches showing various methods of applying adhesives, the bulletin also contains information on quality control for bonding. *Raybestos-Manhattan, Inc.*

L-312

Adhesives, Coatings and Sealers. Catalog A-ZBD-102-JR, called "General Properties of 3M Adhesives, Coatings and Sealers," is a 12-page, two color, 8½ by 11 inch booklet which contains eight fold-out tables listing the uses, characteristics, and general properties of over 170 different adhesives, coatings and sealers available from the manufacturer. The booklet is designed to help select the proper adhesive, coating or sealer for a specific application and to help determine similarities and major differences between products having the same general base material. A cross reference index, included in the catalog, lists over 200 different adhesive, coating and sealer applications and refers to the section of the catalog where a product will be found for each of these specific applications. *Minnesota Mining & Mfg. Co.*

L-313

Cash Payments. "Guide to Factoring" deals with a method of financial operation which brings immediate cash payment to a seller for goods sold on credit, gives him payment in advance for sales which he plans to make within a specified period of the future, guarantees him against credit loss on all merchandise sales, and relieves him of the entire chore of extending credit and collecting bills. The 12 page booklet includes such sections as "Why Businesses Factor," "The Factor's Objective," "Basic Factoring Services," "Current Payments for Future Sales," "Factors' Special Financial Services," "Credit and Collection Service," and several others. *William Iselin & Co., Inc.*

L-314

Adhesives for Duct Work. The manufacturer has prepared a new envelope stuffer on its specialty adhesives, sealants and tapes for the heating and air conditioning industry. The stuffer, which can be imprinted with distributors name and address and used as a mailing piece, describes the special characteristics and properties of each product, gives specific uses, and details the application method for each. *Permacel.*

L-315

Packaging and Paper Converting. A wide range of applications for five types of adhesives developed for the packaging and paper converting fields is described in this new 16-page catalog. Entitled "Packaging and Paper Converting Adhesives," Catalog No. A 100 details features and physical and chemical properties of the adhesives. In addition, the literature describes the company's research in adhesives and cites its customer application and technical service as an aid to solving new or unusual packaging problems. *Armour Alliance Industries.*

L-316

Silicone Coatings. Designated CDS-270, this 16-page bulletin discusses silicone coatings for paper release. The publication deals with a description of various applications of silicone release coatings as well as the chemistry of these materials. The main types of silicone coatings are discussed and some new light is shed on why silicones give good release properties. The publication is illustrated with more than 20 photographs, tables and charts, providing valuable data on the subject. *General Electric Co.*

L-317

Liquid, Slurry and Gas Mixers. "Building Block" top entering mixers are discussed in this eight-page brochure. The mixers are available for open or closed tank mounting in a variety of models with different seals, stuffing boxes and flange facings. The brochure describes each thoroughly, while giving sufficient technical data to permit preliminary selection. In addition, typical installations are illustrated, along with related mixing equipment. *Cleveland Mixer Co.*

L-318

Adhesives Selector Chart. This new Selector Chart, designated Bulletin A-100, shows the outstanding properties of the manufacturer's key adhesives and hardeners . . . their tensile shear strengths at different temperatures and in several fuels. In addition, the operating temperature range, izod impact, coefficient of thermal expansion, and numerous other criteria are indicated. This guide fits into regular three-ring binders or, when unfolded, makes an easy reference wall chart. *Hysol Corp.*

L-319

Moisture and Density Gage. This six-page brochure describes how to use nuclear gages for rapid field determination of moisture and density in soils, aggregates, concrete, asphalt, etc. Profusely illustrated, the brochure shows the nuclear probes in use in a number of determinations and measurements. Full specifications of the gage are provided. *Nuclear-Chicago Corp.*

L-320

Various Hazards. "Hazards" contains information concerning special areas where companies can get technical help to avoid or minimize losses, minimize damages, or obtain fair judgment in court. Laboratory tests, certifications, assistance in meeting public codes, etc., are suggested where possibilities of flammability and explosibility are involved. Other sections of the brochure deal with air and water pollution, plant surveys, appraisals, precautionary labelling, toxicology, bacteriology, slipperiness tests for floors, and litigation. Listed are other booklets available from the organization, and a brief summary of the company's functions and services as consulting chemists and chemical engineers. *Foster D. Snell, Inc.*

L-321

Food Packaging Adhesives. A group of data sheets on food packaging adhesives has been made available. The resin adhesive grades mentioned are for use on a variety of packaging operations, but the manufacturer stresses the fact that resin packaging adhesives are of a selective nature and that manufacturers' recommendations are desirable for each particular application involved. The data sheets cover 15 adhesives in the Cascorez line. Information presented covers, in addition to recommended uses, the properties of the adhesive, method of application, properties of bond, and price per pound, F.O.B. *Borden Chemical Co.*

L-322

Government Specifications. A catalog of adhesives, sealants, coatings, paints, chemicals, cleaners and compounds produced by the company, "Government Specifications" is designed for the use of purchasing and procurement officers. A numerical index lists the specifications in order, regardless of their titles, for easy reference. The main body of the catalog is divided into eight sections based on Federal Supply Class Numbers, and a special section on miscellaneous classes is appended. Specifications are listed by Government number, title, and corresponding code number of the company. *Magic Chemical Company.*

L-323

Particleboard Bulletin. The five-page bulletin, "Mat-Formed Wood Particleboard for Floor Underlayment," contains requirements for floor underlayment specifications. These requirements are designed as the basis for common understanding of those concerned with the manufacture, sales, or use of mat-formed wood particleboard. The requirements establish definite criteria for product performance which must be met by particleboard offered for sale as floor underlayment. The bulletin recently was accepted by the Federal Housing Administration. *National Particleboard Association.*

L-324

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Carbo Fix Epoxy Kits (Carboline) .. Mar. 10
Cascorez (Borden Chemical) ..... Nov. 10
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Cellument Urea—Formaldehyde Resin (Monite Waterproof) ..... Oct. 10
Ceron Water—Soluble Polymers (Hercules Powder) ..... July 12
Chemotec 800 (Polymer Industries) .. Feb. 12
Compribond (Asbiton AG) ..... Sept. 12
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Dry Thread Sealer (3M) ..... Feb. 10
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Elmer's Epoxy Glue and Floor Grip (Borden) ..... Nov. 48
Epothane Farbo-Flex (Farboil) ..... May 10
Epoxy Casting Compound (Hysol) .. Aug. 11
Epoxy Fixture Mount (Permacel) .. Apr. 12
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Field-Stik (Field Paper Box) ..... Oct. 12
Fix'n Patch (Specialty Plastics) .... Feb. 10
Flexible Fillerite (Baird Dynamic) .. Mar. 10
Fluorescent Flex-Stik (Kleen-Stik) .. Aug. 10
Fluoroetch Solution (Acton Labs.) .. June 12
Foam Tape (Foamade Industries) .. Feb. 12
Gap Filling Glue (National Casein) .. Apr. 12
Gasoila Pipe Joint Compound (Federal Process) ..... July 12
Glossy Surface Bondant R-84002 (Raybestos-Manhattan) ..... Jan. 13
Glueable Release Paper (Paterson Parchment) ..... Apr. 10
Glued Lap (H. B. Fuller) ..... Nov. 12
Golden Strip Ceramic Tile Adhesive (Miracle Adhesives) ..... July 12
Gummed Tape (Gilman Paper) .... Sept. 10
Helor Hi-Water Epoxy Concrete (Epoxy Coatings) ..... Jan. 13
Holdtite Belt Repair Kits (U. S. Rubber) ..... Apr. 12
Hornbond (A. C. Horn) ..... Oct. 10
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Hysol High Peel (Hysol) ..... Nov. 10
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Insulating Tape (Connecticut Hard Rubber) ..... Jan. 10
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Jiffy Floor (Monroe) ..... Aug. 10
Join Seal (U. S. Chemical) ..... May 12
Katex Bookbinding (Adhesive Products) ..... Jan. 49
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Kwik-Seal Tub 6 Sealer (Dicks-Armstrong-Pontius) ..... Apr. 10
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Magic Steel Metal Mender (Magic Iron) ..... Oct. 12
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Marble Seal (Watco-Dennis) ..... Sept. 12
Melamine Glue (National Casein) .. June 12
Meta-Bond 331 (Mereco) ..... Oct. 10
Metabond One-Part Epoxy (Metachem Resins) ..... June 12
Meta-Gel 103 (Metachem Resins) .. Aug. 10
Metlbond 406 Unsupported Tape (Narmco Resins) ..... Apr. 10
Morpatex 50 Pigment Binder (Morningstar-Paisley) ..... Apr. 10
Neoprene F-1 (Carboline) ..... Aug. 10
Nu-Edge Carb-N-Set Penetrating Glue (Carb-N-Set Business Forms) ..... Sept. 10
Nu-Surface Concrete (Carborundum) . Oct. 10
Nyl-O-Tape (Hardware Designers) ... Oct. 12
PA—820 Rubber-to-Metal Adhesive (Plastic Associates) ..... Oct. 10
Paint Sheets (Morgan) ..... Feb. 12
Pervenac BM-6X (Nashua) ..... Mar. 12
Petrothene Resins (U. S. Industrial Chemicals) ..... Jan. 13
Pipe Protection Tape (3M) ..... Apr. 12
Plastic Putty (Narmco) ..... Feb. 12
Plastic Steel (Devcon) ..... Jan. 13
Plastix Wet Stick, Plastix Heat Seal (Adhesive Products) ..... Nov. 55
Pliogrip 12-1 (Goodyear) ..... June 10
Plyophen (Reichhold) ..... Feb. 12
Polybond G-1448 (Polymer) ..... May 12
Polyester-Base (Edilon N.V.) ..... May 12
Polyester Film Pre-set Electrical Tape (Permacel) ..... Sept. 12
Polygriptex Water-Based Adhesive (Adhesive Products) ..... Dec. 47
Polymeric Adhesive (Monsanto) .... Apr. 12
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Por-Cold Sealing Compound (Monroe) Sept. 10
Pressure-Sensitive Foam (Richards, Parents & Murray) ..... Nov. 12
Proxseal No. 37-164-8 (Pyroxylin) .. Nov. 10
Reinforced Sealing Tape (Hudson Pulp) ..... Mar. 10
Ren RP-1125 Surface Coat (Ren Plastics) ..... June 12
Re-Seal Pipe Sealer (Reardon Products) ..... Mar. 12
Resin Bonded Quartz Sheet (Cordo Molding) ..... Jan. 13
Resiweld 250 (H. B. Fuller) ..... July 12
Resyn 3600 (National Starch) ..... Nov. 12
Rez-N-Glue (Schwartz) ..... Mar. 10
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Rez-N-Glue 266 (Schwartz Chemical) July 10
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Scotch Brand Protective Tape (3M) . Jan. 10
Scotchkote No-101 (3M) ..... May 12
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Scotchlite (3M) ..... Oct. 12
Scotch-Weld Brand EC-1595 (3M) .. July 12
Scotch-Weld Epoxy Resins (3M) .... Aug. 10
Scotch-Weld Film (3M) ..... June 12
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Self-Adhesive Polyurethane (Morgan Adhesives) ..... June 12
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Silastic RTV 731 (Dow Corning) ... Mar. 12
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Stabond EP-110 Two-Component American Latex) ..... Apr. 10
Strapping Creped Paper Tape (Arno Adhesives) ..... Nov. 12
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Synthacalk (Pecora) ..... Mar 10
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Tape-Stik (Kleen-Stik) ..... Dec. 10
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Plastic Shield

If you fret about unsightly creases in your shoes, or the scuffing of your child's leather sandals, or the nicks and grime on your golf balls, hold your temper. A new urethane coating is just emerging from the laboratories which promises to put an end to such annoyances. Properly applied, this new plastic shield increases the durability of many materials by guarding against abrasion; protects them from chemical and solvent action; thwarts dirt, and gives long-lasting luster. Moreover, the coating is effective over a temperature range from −50 to +350°F.

The first user you may hear about will be Endicott Johnson. This shoe manufacturer has developed a new urethane-treated leather. It is expected to have 700% better wear characteristics than ordinary leathers. By 1965, shoe manufacturers predict, as many as 200 million pairs annually will be treated with urethanes, about 50 per cent of the nation's men's and boys' shoe output.

Meanwhile, the 45 million golf balls and the 43 million square feet of patent leather sold annually are due for similar protection. You will also hear of urethane floor and wood coverings coming into the market. Research is still underway reinforcing the sentiment that a real boon to both consumer and industrial products has been born.

Urethane coatings are members of the same chemical family as the soft, resilient polyether (urethane) foams. However, they have a tighter cross-linkage of molecules which yields extreme hardness and toughness. It is said that this makes them more abrasion-resistant than any other known organic coating. By selecting the type of polyether used, they can be made as stiff or flexible as the job requires.

Snow Tires

Making the seasonal switch to snow tires? You'll extend the life of your conventional set by storing them with care until the Spring, according to the Goodyear Tire & Rubber Co. Preferred spot is a cool, clean, dry location, away from direct sunlight and air currents. Stored tires also should not keep company with electric motors, which generate ozone, a rubber-damaging gas. Stack the off-season set neatly, one on top of the other, on a smooth, oil-free floor. Storage in haphazard piles can distort both tires and bead wires, resulting in a rough ride or premature tire failure, or both.

New for Old

A two-story high mural with a classical theme, in the Music Building of Wayne State University in Detroit, Mich., will be brighter and last longer through the use of modern-day solvents and resins. The artist, Miss Janice Craig, has depicted Pythian dancers celebrating, as Apollo, the Greek god of music, poises to slay the dragon. Miss Craig, who has studied mural painting in Europe and Mexico, says the new mural paint formulations give better durability, brightness and color than was possible previously in mural work.

Road Warns Drivers

A road near Richmond, Calif., is telling drivers to slow down as they approach danger spots. Rock and plastic "rumble strips" are placed ahead of hazardous sections. As the car passes over the strips, vibrations alert the driver. In application, high-impact isopolyester resin is used to bind rock chips into a skid-resistant layer. It is estimated that the strips will last five years under average use.

Lost—One Salami

One of the thousands of items airline passengers left behind last year included one roll of pungent salami. One large airline company recently reported that $1 million worth of merchandise was found in its planes last year. Among other items in the company's lost and found department are two glass eyes (one brown, one blue), a bowling ball, skis, garden snakes, kittens and false teeth.

Research and Development

According to the National Science Foundation, industry spending for research and development in 1960 will total about $10 billion. In 1959, industrial research and development totaled about $9.2 billion, or 15 per cent more than in 1958. The chemical industry alone spent $928 million in 1959.

Business Ups and Downs

A total of 420,000 businesses were launched in the United States between the first quarter of 1959 and the comparable period in 1960. During the same period, it is reported, a total of 345,000 failed or were merged with other businesses.